Training Professionals' Perceptions: A Study of the Relationship between Corporate Culture and Barriers to Implementing Electronic Performance Support Systems in Nuclear Industry Training

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Richard Elliott Cole

M.Ed. Valdosta State University, 1994
B.S. University of the State of New York, 1983

This dissertation, "Training Professionals' Perceptions: A Study of the Relationship between Corporate Culture and Barriers to Implementing Electronic Performance Support Systems in Nuclear Industry Training," by Richard Elliott Cole, is approved by:

Dissertation Committee Chair	J. D. Thomerson J. D. Thomerson, Ed.D. Associate Professor
Committee Member	Robert Bauer Robert E. L. Bauer, Ph.D. Professor of Psychology and Counseling
	Arnold K. Murdock, Ed.D. Associate Professor
	Andrew J. Brovey Andrew J. Brovey, Ed.D. Associate Professor
Dean of the College of Education	Thomas Reed, Ed.D. Dean, College of Education
Dean of the Graduate School	Ernestine H. Clark Ernestine H. Clark, Ed.D. Dean, Graduate School

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ABSTRACT

The purpose of this study was to identify perceived barriers to the effective implementation of Electronic Performance Support Systems and identifiable relationships among these barriers. Additionally, relationships between these barriers and the corporate culture of the respondents' organizations were investigated. This study centered on the perceptions of training professionals in the nuclear training industry.

Respondents rated the Frequency, Impact, and Importance of barriers to effective implementation of an Electronic Performance Support System using an instrument developed through a literature review. The corporate culture of the respondents was determined using the Organizational Culture Assessment Instrument developed by Cameron and Quinn (1999). A self-administered, mail delivered questionnaire was used to conduct the study.

Findings included: (a) the instrument had internal consistency ($\alpha > 0.70$), (b) barriers clustered into five factors each in the attributes of Frequency, Impact, and Importance, (c) no statistically significant relationships between barriers and the corporate culture in the nuclear training industry were identified.

Factors identified in this study are similar to those in other reports on organizational change. This indicates implementation of Electronic Performance Support Systems may be facilitated using proven strategies to address the implementation barriers identified. The lack of significant relationships between implementation barriers and the specific combination of culture types evidenced in this study may indicate the barriers identified are generalizable to multiple cultures.

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DEDICATION

I dedicate this study to my loving and indomitable wife, Laura. Her spirit and love supported me through two careers, and form the cornerstones of my adult life. The thousands of miles we spent on the highway getting here were worth the trip.

Chapter 1

INTRODUCTION

This chapter introduces the problem and the theoretical constructs upon which the study is based. In addition, a statement of the problem, purpose of the study, research questions, hypotheses, and rationale for the study are discussed. Finally, limitations of the study are described and operational definitions provided.

Introduction to the Problem

In the United States, there are over 100 commercial nuclear power plants providing approximately twenty-five percent of the nation's electric generation capacity (US NRC Website, 2002). Nuclear power plants employ from 500 to 700 persons depending on the generating capacity of the plant and the number of nuclear reactors at the location. The United States Nuclear Regulatory Commission (NRC), as the responsible agency authorized to ensure public safety by Congress in the United States Code of Federal Regulations, licenses and provides oversight of these power plants.

Nuclear power plants are required to undergo periodic renewal of their operating license to meet the requirements of the NRC. To ensure the nuclear industry continues to meet the stringent requirements of the NRC, the Institute of Nuclear Power Operations (INPO) was established in 1979. In 1985, the NRC ruled the Institute of Nuclear Power Operations would act as the accrediting body for the training programs required to meet nuclear power plant licensing standards (INPO, 2002). By virtue of accreditation of their training programs, each nuclear station becomes a component site of the National Academy for Nuclear Training.

Licensing criteria for nuclear power plants requires a training program designed to ensure the plant's personnel are capable of operating and maintaining the nuclear reactor and support facilities. Current training programs fall under two general categories—Operations Training programs, and Maintenance and Technical Training programs. Operations Training programs include initial and continuing training programs for Licensed Reactor Operators and non-licensed operators.

Licensed operators primarily perform their functions in the control room of the nuclear power plant and are in direct control of the nuclear reactor. Non-licensed personnel provide maintenance and support of the reactor support and electrical generation systems. While all operators are trained by the utility, only licensed operators are examined by, and receive their operator's license from, the Nuclear Regulatory Commission. Non-licensed operators and maintenance and technical personnel receive initial and continuing training and certifications from the individual utilities under the authority of the license granted by the Nuclear Regulatory Commission, and are working under the supervision of licensed reactor operators while performing their duties.

A periodic accreditation renewal process assesses the plant's ability to maintain initial and continuing training programs in compliance with a standard set of objectives and criteria. Accreditation criteria include a requirement to assess the effectiveness of the training programs in using a systematic approach to training. This systematic approach is used to develop and maintain training program content.

Initial training programs range in length from several weeks for degreed engineers, to 18 months for licensed reactor operators. The content of annual continuing training programs is based on the performance needs of the recipients and typically range from 30 hours for engineers; over one hundred hours for skilled maintenance craftpersons; and over 200 hours for licensed reactor operators. Both initial and continuing training programs consist of classroom instruction, laboratory and work setting exercises, and real-time reactor simulator training. Continuing training program content consists of fundamental refresher training and specific content developed to improve the performance of the participants.

Training programs supporting the operation of nuclear power plants are required by the United States Code of Federal Regulations to be based on a systems approach to training (10 U.S.C. § 55.4). The systems approach adapted by the nuclear industry is similar to the instructional systems development (ISD) model developed and adapted by the United States armed services in the mid 1970's (Finch & Crunkilton, 1989). This instructional systems design model is widely accepted in the training industry and vocational education programs. Instructional systems design as implemented by the military consists of five phases including Analysis, Design, Development, Implementation, and Control. The nuclear industry has established a model with five similar phases including Analysis, Design, Development, Implementation, and Evaluation (INPO, 1986).

A systematic analysis of the tasks a person must be able to accomplish to safely and effectively operate and maintain the nuclear power plant provides the basis for nuclear training programs. One of the accreditation criteria is that the plant must demonstrate a linkage between the task analysis and the training materials used in the training programs. The training program must also demonstrate linkage between the learning objectives sequenced into the materials and the evaluation instruments used to determine student mastery of the learning objectives. These relationships lead to the development, and continuous maintenance, of matrices composed of several hundred tasks and several thousand learning objectives and test items to support multiple training programs. This has led to the development of complex hard copy or electronic repositories of training components (for instance, tasks, objectives, and training materials) to maintain programs in a comprehensive and easily presented structure to meet accreditation requirements. Analysis and development of job requirements, and development of the task analyses, learning objectives, and resulting training and evaluation materials, requires a high level of performance from the instructors in the training department of a nuclear power plant.

Instructors at nuclear power plants are typically selected from the ranks of the programs they will support and are subject matter experts in their specific field of employment. However, few nuclear industry instructors have formal education in instructional design, training delivery, or program evaluation prior to their assignment to these duties. To develop needed instructor skills, most nuclear plants have developed internal training programs to prepare new instructors for assignments in a training department. Instructor training programs are also required to meet National Academy for Nuclear Training standards and are evaluated during the periodic accreditation renewal.

Instructors are required to provide increasingly higher performance to meet business goals causing the role of the instructor to be continuously evolving. In the nuclear industry, instructors are becoming a resource for improving workplace performance for their training program constituencies. Developing performance improvement methodologies in training programs requires timely access to the task analyses and existing learning objectives and training materials contained in the associated training program matrices.

One means of attaining higher performance in training programs and other areas of the workplace has been through the application of Human Performance Technology principles and practices. To meet the need for increased personal productivity, coupled with increased task flexibility, industry and academia collaborated to develop the practice of Human Performance Technology. Performance technology methods are being used to improve organizational and personal effectiveness to meet the needs of the modern workplace (Kaufman, Thiagarajan, & MacGillis, 1997; Perlstein, 1997; Rosenberg, 1995). The International Society for Performance Improvement defines Human Performance Technology as "the systematic approach to improving productivity and competence" (International Society for Performance Improvement Website, 1998). A more detailed definition, provided by the International Society for Performance Improvement describes Human Performance Technology as “A systematic set of methods and procedures, and a strategy, for solving problems, or realizing opportunities related to the performance of people (Stolovich & Keeps, 1999, p. 10)”.

One area of emphasis in developing performance improvement interventions is determining what can be changed about the job to make it easier for workers to accomplish. For many years, training and job aids have been the primary means of performance support in the workplace. The primary difference between training and the use of job aids is that training takes place in preparation for work and in preparation of the worker for the workplace. Job aids are used to supplement or replace training during the actual performance of work (Robbins, Doyle, Orandi, & Prokop, 1996: Rossett, 1996). Frequently, job aids are used when the tasks being performed are complex, when tasks are not performed often, or when tasks are changed and the workers must alter their performance methods.

Training programs in the nuclear industry make extensive use of procedures, job aids, forms for data collection and retention, and routing through various levels of format and technical reviews. This ensures high quality training materials are developed to meet the needs of trainees and sponsoring training program managers. These processes were developed as an augmentation of the education programs used to prepare instructors. Generally, Instructional Technologists, commonly persons with education degrees or significant experience in the adult education process, develop and maintain instructor training programs and oversight of training management systems.

Over the past several years, Electronic Performance Support Systems have become an increasingly common intervention recommended as a cost-effective alternative to training. An Electronic Performance Support System is a computer application that integrates traditional training development and delivery methods with software based support to improve performance. These systems provide a barrier combination of skills training, task specific instruction, expert advice, and real-time on-the-job support to employees (Stevens & Stevens, 1996; Des Jardins & Davis, 1998; Rossett, 1996). The purpose of an Electronic Performance Support System is to improve worker performance and productivity using automated tools, sometimes called coaches, wizards, expert systems, or other task specific electronic job-aids.

Electronic Performance Support Systems are sometimes described as providing just-in-time training to the individual (Cole, et al., 1997). In other words, the Electronic Performance Support System allows the worker to learn while performing the task (Des Jardins & Davis, 1998; Desmarais, et al., 1997; Rossett, 1996). In the nuclear industry, implementation of Electronic Performance Support Systems to support the instructional systems development process has become a common supplement to instructor training. These Electronic Performance Support Systems aid in maintaining the complex training matrices and training materials required to sustain accreditation of the plant's training programs.

Background of the Problem

Use of Electronic Performance Support Systems to support maintenance and development of training programs is becoming increasingly common in the nuclear industry. A recent survey of fourteen nuclear power plants, conducted by personnel at the Columbia Generating Station, indicated all of these plants are using some type of Electronic Performance Support System to support training management and/or development (R. W. Hayden, personal communication, April 22, 2002). These systems ranged from self-developed databases using commercial off the shelf software, to custom made or commercially developed systems specifically designed for training program management. Some of these systems are single station proprietary systems while one utility has networked their systems to provide management for ten nuclear stations in two states to support over eight thousand employees.

The cost of developing and implementing an Electronic Performance Support System is often quite consequential. Respondents to an American Society for Training and Development (ASTD) sponsored survey indicated the median expenditure for development of Electronic Performance Support Systems in their organizations was $52,100 (411 responses), while their total expenditure for training was $202,400 (393 responses) (Kemske, 1997). Similar costs in the implementation of Electronic Performance Support Systems to support training in the nuclear industry have been encountered. The budget for implementation of Electronic Performance Support Systems to support training programs at the utility with ten nuclear power plants is over one million dollars (W. E. Hardin, personal communication, March 14, 2002).

Barriers to Implementation of Electronic Performance Support Systems

Electronic Performance Support Systems were heralded as the "wave of the future for employee training" reported George Benson (Benson, 1997, p. 48). However, Benson went on to report there was a need for additional research into the effectiveness of Electronic Performance Support Systems as a tool in employee training. Rossett (1996), indicated that though Electronic Performance Support Systems' "desirable capacities should ensure that Electronic Performance Support Systems are revolutionizing the workplace" (p. 574), there were still many obstacles to attaining this outcome. Alison Rossett (1996), listed a number of reasons contributing to the slowness of proliferation including: lack of cross-functional coordination, interface frustration, lack of user preparedness, absence of an organizational infrastructure, absence of high-level ownership, cost of the Electronic Performance Support System, and resistance to innovation. Benson (1997) and Kemske (1997) described a lack of Electronic Performance Support System awareness and implementation cost as the two leading barriers to Electronic Performance Support System employment. Other known barriers encountered in developing and implementing Electronic Performance Support Systems include underestimating the time to develop the system, not testing the new systems adequately, and lack of a budget for maintenance and future support (Hall, 1996; Kemske, 1997).

Additional barriers to effective implementation of Electronic Performance Support Systems have been experienced by other developers. Noted Electronic Performance Support System developer Gloria Gery (personal communication, December 19, 1998), listed several additional barriers to implementing Electronic Performance Support Systems. These barriers included: (1) presumptions training will be the primary means of skill development, (2) information systems department perceptions that user participation in Electronic Performance Support System development will add time to projects—so they don't invite user participation, (3) belief that programmer's time is more important than that of the users of the system, (4) control issues who is in charge of the system, (5) lack of high-level sponsorship, and (6) focusing on the system performance/response rather than the worker's performance.

Another professional Electronic Performance Support System developer, Larry Harrison (personal communication, December 24, 1998), related a case describing significant resistance to Electronic Performance Support System implementation in one organization. In this case, the root of the resistance was that, in the past, travel had been associated with training. The workers were resisting giving up their opportunity for extensive, desirable travel. The barriers identified through these communications and published research provides the content validity for the barriers investigated in this study.

Organizational Culture

Many of the barriers encountered in implementing Electronic Performance Support Systems are common to other organizational change issues. Clifford Geertz (in Stolp & Smith, 1995) defines culture as the transmitted symbols of language, both written and implicit. This includes such constructs as norms, beliefs, traditions, and myths ascribed to a group of people. Stolp and Smith then relate these attributes to the culture of a school and summarizes that culture is what incumbent educators mean when they explain to new teachers "the way we do things around here" (Stolp & Smith, 1995, p. 13). John Kotter (1996) also uses this phrase in describing the error in change management of neglecting to anchor change in corporate culture.

Kotter (1996) presents eight errors commonly encountered in organizational change projects. These errors include (1) allowing too much complacency, (2) lack of a guiding coalition, (3) underestimating the power of vision, (4) under communicating the vision, (5) permitting obstacles to block the new vision, (6) failing to create short term wins, (7) declaring early victory, and (8) neglecting to anchor changes in the corporate culture. The consequences of these errors are that new strategies are not well implemented, acquisitions do not achieve the synergies, reengineering takes longer, and costs more than expected, downsizing does not achieve expected cost benefits, and quality programs do not deliver expected results (adapted from Kotter, 1996, p. 16). Changing organizational culture is difficult and often contributes to inhibiting specific change projects in an organization (Kotter, 1996; Kotter & Heskett, 1992; Atchison, 2002).

However, not all cultures exhibit significant resistance to change. Daniel Denison (2001) indicates cultures can be more or less responsive to change depending on their orientation to four cultural traits: involvement, adaptability, consistency, and mission. In describing these traits, Denison (2001) orients them in relationship to whether cultures are flexible versus stable, and externally or internally focused. Other researchers similarly represent this orientation.

The cultural orientation of organizations and a relationship to change issues is also presented by Hooijberg and Petrock (1993). In their publication, two dimensions of control are presented—flexibility versus control, and, internal versus external focus. This model has been used in support of organizational change support projects in several major corporations including several nuclear stations.

More recently, at a presentation to an Institute of Nuclear Power Operations sponsored workshop on the organizational nature of human performance, Dr. Frank

Petrock (2002) indicated corporate cultures might be classed in four primary categories—Hierarchy, Clan, Adhocracy, and Enterprise. His studies of several nuclear stations indicate their corporate cultures fit into two areas of competing values—Direction of Focus, with cultures being either internally or externally focused; and, Degree of Control, with cultures tending toward flexibility, or stability and control. These competing values tend to align in four primary cultures with eight primary factors related to these cultures: Hierarchy—Process and Rules/Position; Clan—Human Resources and Team; Adhocracy—Creative/Change and Growth/Boundary; and, Enterprise—Task/Competitive and Rational/Goal. Each of the cultures has positive and negative characteristics that make them more or less resistant to varying types of change.

Need for the Study

To improve worker efficiency, Electronic Performance Support Systems are gaining acceptance as an increasingly important tool in the nuclear industry (Jenco, 2002). They provide a means of improving the management of the complex technical programs such as training programs in the nuclear industry. While there may be issues in implementation of these systems, they are considered a viable tool for future consideration. Therefore, it is important to ensure these systems are designed and implemented using the most effective means available. This effort requires performance technologists, programmers, instructional technologists, program planners, and training managers to have a thorough knowledge of the strengths, attitudes, motivations, and performance limitations of the expected end-users of the systems—and to work with the end-users in designing the performance support system.

Effective expenditure of resources for the development and implementation of Electronic Performance Support Systems in nuclear industry training departments requires program managers to ensure systems are designed efficiently and implemented in a manner that ensures they will be utilized to the maximum extent possible (Sherry & Wilson, 1996). A thorough understanding of barriers to effective Electronic Performance Support System implementation will provide valuable insights to system developers and program managers in their efforts. While a significant body of knowledge related to the technical development of Electronic Performance Support Systems is available, a significantly smaller quantity of information is available related to the programmatic issues encountered during implementation of Electronic Performance Support Systems.

Purpose of the Study

The purpose of this study is to determine if there are relationships between organizational culture factors and commonly encountered barriers to implementing Electronic Performance Support Systems. Improved knowledge of common implementation barriers as they are related to organizational factors will provide information to future implementation managers to improve their effectiveness in effectively implementing Electronic Performance Support systems. These relationships will assist program managers in establishing improved implementation strategies, facilitate managers' effective use of resources, and assist instructors in reaching desired performance levels.

Research Questions

The following questions guided this study:

What are the relationships between organizational culture and training professionals' perceptions of barriers to implementing Electronic Performance Support Systems?

What are the relationships among training professionals' perceptions of individual barriers to implementing Electronic Performance Support Systems?

Null Hypotheses

The research will indicate no statistically significant relationship between organizational culture and barriers encountered when implementing Electronic Performance Support Systems.

The research will indicate no statistically significant relationships among training professionals' perceptions of individual barriers to implementing Electronic Performance Support Systems.

Operational Definitions

Electronic Performance Support System

A computer application providing software-based performance support for instructional systems development and/or the management of training programs.

Barrier

For the purpose of this study, an organizational or individual characteristic or property, either physical or construct in nature, which would negatively influence the implementation of an Electronic Performance Support System.

Organizational Culture

For the purposes of this study, organizational culture is defined as those factors that identify the organization in relation to Direction of Values—Internal or External focus; and, Degree of Control—Flexibility or Stability and control.

Culture Type

For the purpose of this study, organizational cultures are classified in four types based on cultural orientation. There are four culture types of relevance in this study—Clan, Adhocracy, Hierarchy, and Market.

Cultural Factors

For the purposes of this study, cultural factors are those attributes of the culture that define its orientations. The four types of culture are oriented to their defining factors as follows:

Clan culture.

Human Resources—Organization has a high concern for people. Supports career planning and has a strong focus on training, education, and personal growth.

Team—Organization values cooperation and working well with others. Participative decision-making is common and conflicts and differences of opinion are openly managed.

Adhocracy culture.

Creative / Change—Readiness for change is valued. Adaptation is stressed and individuals are encouraged to take individual initiative. The orientation of the organization is toward being the best in their field.

Growth / Boundary—Employees are encouraged to be entrepreneurial and ready for new challenges.

Hierarchy culture.

Rules / Position—Predictability is highly values. Documentation, reports, and tracking mechanisms are important. Everyone follows established rules and works within limits of roles and reporting relationships.

Process—Efficiency is valued and smooth workflow is expected. Processes are structured to avoid inefficiencies. Employees know how their work interfaces with the work of others.

Market culture.

Task / Competitive—The organization values being task oriented and taking aggressive action to meet competitive challenges. Employees are expected to get the job done first. Winning is what counts.

Rational / Goal—Goals are clear and accountability is established. Members work to meet challenging objectives. Members are logical and rational.

Limitations of the Study

The conclusions reached as a result of this study will be subject to the following limitations:

The restrictions associated with the use of a self-administered survey instrument and the response rate of participants including:

The use of a voluntary survey instrument only provides responses from those respondents who are cooperative and accessible (Isaac & Michael, 1995).

Respondents to the surveys may be those persons most interested in the development or implementation of Electronic Performance Support Systems, potentially instilling some degree of bias in the results.

Conclusions will be generalizable only to populations and situations similar to those within the experiences and organizational cultures of participants in this study.

Assumptions

This study and resulting conclusions will be subject to the following assumptions:

Participants in the study will provide a representative sample of the perceptions and experiences of training managers, Electronic Performance Support System developers, performance technologists, and instructors in the nuclear industry.

The instrument used for the study has sufficient content validity and reliability to allow generalization of the results.

Summary

This chapter presented an introduction to the training programs in the nuclear industry and the need for the Electronic Performance Support Systems that are currently being implemented to support the maintenance of these training programs. Chapter 1 includes a statement of the problem studied, the purpose of the study, and the need for the study. Operational definitions, assumptions, and limitations are presented. Research questions investigated in the study are included.

Chapter 2 is devoted to a review of literature related to the nuclear industry, instructional systems design, human performance technology, Electronic Performance Support Systems, and organizational culture. The basis of the development of Electronic

Performance Support System as an augmentation for instructor development, and training program development and management is explored in this chapter. Relationships between cultural factors and barriers to implementation of Electronic Performance Support System are developed. Major theorists and studies in the aforementioned areas are reviewed.

Chapter 3 contains the research methods and procedures utilized in the study. A description of data collection methods and instruments is included. Methods of data analysis are provided.

Chapter 4 provides an analysis of the data. This data will be related to the organizational factors and research questions of the study. Descriptive statistics and statistically significant findings are presented.

A summary of the findings and conclusions from the study are provided in Chapter 5. Implications of the findings and conclusions, and recommendations for further study, are presented.

Chapter 2

REVIEW OF LITERATURE

This chapter presents a review of literature from journal articles, reference books, personal communications, and research publications related to the use of Electronic Performance Support Systems to support the instructional systems design process in the nuclear industry. The literature review provides the theoretical framework for this study. Relevant to this study is literature regarding the following subjects: (1) The nuclear industry, including the relationships between the U.S. Nuclear Regulatory Commission, the Institute for Nuclear Power Operations, and the National Academy for Nuclear Training; (2) Nuclear Training Programs, including training program accreditation, and instructor selection and training; (3) Application of Instructional Systems Development processes in nuclear industry training programs; (4) Human Performance Technology, including definition, history, theoretical foundation, and use in the nuclear industry; (5) Electronic Performance Support System—definition, uses, development, uses in the nuclear industry, and barriers to implementation; and, (6) Corporate Culture, including background, types of cultures, instruments used for determining culture traits, and relationships between corporate culture and resistance to change.

The Nuclear Industry

Relationships between the U.S. Nuclear Regulatory Commission, the Institute for Nuclear Power Operations, and the National Academy for Nuclear Training.

There are over 100 commercial nuclear power plants in the United States providing approximately twenty-five percent of the nation's electric generation capacity (US NRC Website, 2002). Each nuclear utility is required to undergo periodic renewal of their operating license to meet the requirements of the Nuclear Regulatory Commission. Nuclear Regulatory Commission officials base renewals on direct observation and the findings of an independent accrediting body. This independent accrediting body is the Institute of Nuclear Power Operations. The Institute of Nuclear Power Operations was established by the nuclear industry in 1979. All United States utilities with nuclear operating licenses contributed to the establishment of the Institute of Nuclear Power Operations and are members of the of the institute today.

Organized in a manner similar to most corporations, the Institute of Nuclear Power Operations has a Board of Directors, elected by the membership of the institute, to provide governance. Professional nuclear industry personnel manage the day-to-day operation of the institute under the direction of a President elected by the Board of Directors. An Advisory Council from outside the Institute of Nuclear Power Operations membership provides advice on the objectives and methods for conduct of the institute. The Advisory Council is composed of 12 to 18 training and corporate professionals from outside the nuclear industry. Members of the Advisory Council are typically educators, engineers, scientists, and industrialists.

A Nuclear Regulatory Commission ruling in 1985 designated the Institute Of Nuclear Power Operations to act as the accrediting body for the training programs required to meet licensing standards for nuclear power plants (INPO, 2002). The National Academy for Nuclear Training, formed in 1985, focuses industry efforts to ensure high standards in training and qualification and to promote professionalism of nuclear plant personnel (INPO, 2001). Operated under the auspices of the Institute of Nuclear Power Operations, the academy provides three primary functions—oversight and support of nuclear utility training activities at individual plant training facilities, support of the activities of the independent National Nuclear Accrediting Board, and the conduct of the training related activities of the institute. By virtue of the accreditation of their training programs, each nuclear site is a component of the National Academy for Nuclear Training.

The National Nuclear Accrediting Board reviews the quality of plant and utility training programs and makes the final decision on accreditation renewal of existing training programs and initial accreditation of new training programs. This board is made up of eminent American scholars and executives. While the board is supported by the Institute of Nuclear Power Operations, its decision-making authority related to accreditation of programs is independent of the Institute of Nuclear Power Operations. The board meets several times a year to determine the continued accreditation of the nation's nuclear training programs.

Nuclear Utility Training Programs

Most nuclear power plants employ from 500 to 700 persons depending on the generating capacity of the plant and the number of nuclear reactors. These employees participate in formal training programs accredited by the National Academy for Nuclear Training. Accrediting activities for nuclear industry training programs are conducted in a manner similar to public education programs.

The United States Code of Federal Regulations (10 U.S.C. § 50.120) requires training programs supporting the operation of nuclear power plants to be based on a systems approach to training. This approach is similar to the Instructional Systems Development (ISD) model developed and adapted by the United States armed services in the mid 1970s (Finch & Crunkilton, 1989) that included five phases including Analysis, Design, Development, Implementation, and Control. Another model of Instructional Systems Design in the American Society for Training and Development Technical and Skills Training Handbook (Biebel, In ASTD, 1994) provides for three phases—Analysis, Design, and Development and Implementation. The nuclear industry has established a model with five phases—Analysis, Design, Development, Implementation, and Evaluation (INPO, 1986).

Training programs at nuclear power plants provide initial and continuing training programs for persons who maintain and operate nuclear power plants. Initial training programs range in length from several weeks for degreed engineers, to 18 months for licensed reactor operators. Annual continuing training programs range from 30 hours for engineers to over one hundred hours for skilled maintenance craft persons, and over 200 hours for licensed reactor operators. Initial and continuing training programs consist of classroom instruction, laboratory, and work setting exercises, and real-time reactor simulator training for licensed operators.

The Training Program Accreditation Process

A nuclear power plant's ability to maintain their initial and continuing training programs in compliance with a standard set of objectives and criteria is assessed during a periodic accreditation renewal process. The Institute of Nuclear Power Operations has established guidelines for the conduct of operations at nuclear power plants in the United States. These guidelines include criteria for operations of the nuclear reactor and support equipment, maintenance of the physical plant, and training of plant personnel. The accreditation process resulting from portions of these criteria assess the effectiveness of the utility's training programs in using the systematic approach to training.

The accreditation process is composed of four major components. First, the nuclear power plant performs a comprehensive self-evaluation of their programs using the objectives and criteria established by the Institute of Nuclear Power Operations. This formative self-assessment is conducted by a team of utility experts and peers from other nuclear power plants. Weaknesses identified in the comprehensive self-evaluation are acted upon by the nuclear power plant as part of the evaluation phase of the instructional systems design process.

The second component of the accreditation process occurs at the end of the accreditation period, the power plant completes an Accreditation Self-Evaluation Report that is reviewed by a team of accreditation specialists, and nuclear industry peers. This report is a critical analysis of the training programs being reviewed related to their meeting the accreditation criteria and objectives. Utilities present any areas for improvement identified during the accreditation cycle and the status of the corrective actions to correct these weaknesses. Major program changes, information regarding training conducted throughout the accreditation period, and demographic and leadership information related to the training staff are identified in the report.

Part three of the accreditation process follows the review of the Accreditation Self-Evaluation Report. After their review, a team of Institute of Nuclear Power Operations' accreditation specialists and industry peers conduct a weeklong on-site assessment of the training programs at the power plant. This summative evaluation includes observation of training in progress, review of records of training completed during the accreditation cycle, and interviews with students, instructors, program owners from the line organization, and training management at the power plant. The accreditation team also reviews training program content to ensure training is based on the task analysis for the members of the training program. A review of selected program content ensures learning objectives, training materials, and evaluation instruments are properly aligned and at the appropriate cognitive level to ensure personnel are capable of operating and maintaining the nuclear power plant at an acceptable standard. At the end of the accreditation assessment, the team provides a written supplement to the stations Accreditation Self-Evaluation Report that identifies any additional areas for improvement in the plant's training programs and concurs or disagrees with the status of any self-identified areas for improvement. This report is provided to the National Nuclear

Accrediting Board for review in their decision to grant or renew accreditation of the training programs at the nuclear power plant.

The final component of the accreditation process consists of the National Nuclear Accrediting Board's review of the self-assessment report and the report of the Accrediting team visit. After review of the reports, the Board conducts an interview of the nuclear power plant's executive leadership, line sponsors of the individual training programs being considered for accreditation, and training management. Based on the results of this board and the review of the assessment materials, the board will make a decision, to renew or grant accreditation, place a training program on accreditation probation, or remove accreditation from a training program.

Nuclear Power Plant Training Programs

Accredited training programs at nuclear power plants are divided between two major skill sets—operators of the nuclear power plant, and maintenance and technical professionals. Among the operators are three disciplines—Non-Licensed Operator, Reactor Operator, and Senior Reactor Operator. The non-licensed operators provide in-plant operating expertise in the operation and control of power production, non-reactor control, and reactor support systems. They do not provide direct control or safety functions in the operation of the nuclear reactor(s). Approximately 12 months of initial training and 120 hours of continuing training annually are provided for non-licensed operators.

Licensed operators are divided into two primary skills—Reactor Operator and Senior Reactor Operator. The licensed operators are trained by the utility. They receive their license from the Nuclear Regulatory Commission after completing a training program and satisfactorily passing a comprehensive written examination and an on-the-job evaluation conducted by the Nuclear Regulatory Commission. Reactor Operators exercise direct control of the nuclear reactor and generally act as the liaison between control room operations supervisors and the non-licensed operators in the field. Reactor Operators receive about 18 months of initial training and over 200 hours of continuing training annually.

Senior Reactor Operators complete the same tasks and training as Reactor Operators and receive additional training in Reactor Safety and Management skills. They act as Unit Supervisors of the Reactor Operators and provide additional coordination of groups of non-licensed operators on each work shift. Senior Reactor Operators receive about 20 months of initial training and over 200 hours of continuing training annually.

Several Senior Reactor Operators at each nuclear power plant are specially trained to become Shift Technical Assistants. The Shift Technical Assistant is trained to provide additional oversight and independent advice to the Shift Manager under unusual and potential emergency conditions. They receive about 6 weeks of additional initial specialized training beyond Senior Reactor Operators and specialized training and evaluation during continuing training.

The last Licensed Operator-training program is for Shift Managers. These specially designated Senior Reactor Operators receive additional training in shift management, leadership, and emergency procedures. Shift Managers are in overall charge of a shift of licensed and non-licensed operators and are responsible for the overall operation of all reactor systems. They would also provide liaison with the Nuclear Regulatory Commission and state and local officials in the case of a nuclear emergency until specialized response organizations are activated. The Shift Manager is the senior member of the operations organization and supervises the operation of one or more reactors.

Operators typically attend continuing training during six or seven training cycles per year. The operators spend about six weeks on various shifts conducting reactor plant operations followed by a week of continuing training. During the training period, operators attend classroom lectures, seminars, laboratories, and participate in real-time simulator training with significant fidelity to actual plant conditions. These training sessions are facilitated by instructors certified in their training programs. A typical operations training program at a power plant with two reactors will have about 20 instructors for a population of 150 operators.

At the completion of their initial training program, all licensed operators are required to pass a comprehensive licensing examination approved and administered by the Nuclear Regulatory Commission. This examination consists of a written examination and a performance evaluation conducted in the station's reactor simulator facility. Upon completion of the examination process, the operators receive a license from the Nuclear Regulatory Commission.

Maintenance programs at a nuclear station are divided into three disciplines including Mechanical, Electrical, and Instrument Maintenance. These classifications are based on the technical skills of the workers and are similar to other industrial maintenance training programs. Training for these persons is similar to trade skills apprenticeships with initial training programs varying in length from several months to years depending on the entry skills of the workers. Often, workers at the power plant start in unskilled labor pools and work their way into maintenance positions. The continuing training programs average about 75 hours per year. These programs are facilitated by station certified instructors with an instructor to student ratio of about one instructor to thirty students.

There are three technical disciplines included in the accredited training programs. The first two normally consist of non-degreed workers who maintain the chemical and radiological controls processes for the power plant. These workers are normally trained in their skills both on-the-job and in formal classroom and laboratory training sessions. The initial training programs for these skills range in length from 6 months to one year. There are typically one or two instructors for each of these disciplines with an instructor to student ratio of about one instructor to thirty or more technicians.

Degreed and/or licensed engineers make up the last technical discipline. These engineers maintain the reactor and systems design for the nuclear power plant. Engineers are recruited from accredited engineering programs and are provided specific orientation training on nuclear systems and operation to support them in their engineering specialties. The initial engineering orientation program takes about 4 months with a follow-on certification program conducted by incumbent engineers. Incumbent engineers normally attend about 30 hours per year of discipline-specific technical and general engineering training. There are generally one or two instructors to support an engineering program population of from 50 to 100 engineers at a nuclear power plant.

Instructor Selection and Training

Instructors at nuclear power plants are normally selected from among the incumbents of the skills they represent. This is similar to the instructor selection process often used in vocational education programs. The Institute of Nuclear Power Operations provides guidelines for instructor selection and training (INPO, 1991).

Based on the Institute of Nuclear Power Operations guidelines, the nuclear power plant or utility develops and implements an instructor training and development program to support the educational and business needs of the station. Some stations or utilities have adapted additional standards such as those of the International Board of Standards for Training and Performance Improvement as part of their instructor development program. Persons selected to become instructors are provided education on training delivery and instructional systems design.

Instructor training programs are normally developed and conducted by the nuclear power plant or collaboratively by a group of power plants belonging to a nuclear utility. The programs typically consist of a two-phase academic program integrated with practice delivery and evaluation for the instructor candidate. Instructors are trained in the conduct of classroom lectures, laboratory exercises, on-the-job training, and real-time simulator facilitation. The first phase of the academic training includes such topics as adult learning theory, instructional design, active learning techniques, and classroom management. Additional topics include use of media, questioning techniques, learning styles, and student evaluation.

The second phase of the instructor-training program consists of instructor training on the systems approach to training process, and any administrative or process controls required in managing the training programs at the specific utility. In this phase, instructors learn the practical application of the practice of Instructional Systems Design. The two phases are typically conducted over a two weeks period.

At the completion of the academic portion of the training, the instructor is mentored by a qualified instructor and conducts practice and actual teaching sessions under the supervision of a qualified instructor evaluator. These sessions are designed to bring the new instructors skills up to accepted standards prior to allowing them to teach independently. Additionally, the instructional systems design aspects of their duties are frequently developed through a regimen of on-the-job training and certification. A typical instructor-training program may take from six months to a year to complete before the candidate receives final certification as a fully qualified instructor. In some cases, the instructor may be allowed to perform selected duties, such as teach only in a single training setting, with interim qualification.

Application of Instructional Systems Development in Nuclear Training Program Design

Nuclear power plant training programs are required to be based on a systems approach to training. The systems approach used by the nuclear training industry is prescribed by the Nuclear Regulatory Commission and Institute of Nuclear Power Operations and consists of five phases—Analysis, Design, Development, Implementation, and Evaluation (INPO, 1986). Implementation of the systematic approach to training prescribed by the Institute of Nuclear Power Operations is assessed during the accreditation process.

The Analysis phase of the systematic approach to training used in the nuclear industry starts with a systematic analysis of the tasks a person must be able to accomplish to safely and effectively operate and maintain the nuclear power plant. These analyses are based on job and task analysis conducted in a manner consistent with the Instructional Systems Development methodology and Institute of Nuclear Power Operations guidelines. In some cases, such as with the training program for engineers, an industry-wide study was conducted to determine the appropriate competencies to be included in the training program. In other programs, such as licensed reactor operators, the task analysis is based on a set of knowledges and skills prescribed by the Nuclear Regulatory Commission and supplemented with a plant-specific job analysis conducted by the individual power plant's line and training departments.

During the design phase of the systematic approach to training process, learning objectives are derived from the task analysis to meet the cognitive levels described in Blooms Taxonomy (Bloom, 1956). Associated student evaluation instruments are constructed from the learning objectives to evaluate students' mastery of the material. These learning objectives are constructed to support mastery of the tasks with which they are associated. Learning objectives are then sequenced into units of instruction and training program requirements are developed to guide the development of training materials to support mastery of the learning objectives.

Development of training materials and lesson plans is the next phase of the systematic approach to training. Training materials are developed to support mastery of the learning objectives. Line and training managers participate in the review and development of the training materials to ensure their technical accuracy and efficiency of use to maximize student learning. Instructional Technologists, or other designated specialists, review the training materials and provide advice on appropriate learning strategies and training settings to meet accepted adult learning theories.

In the Implementation phase of the systems approach to training, instruction is provided to the students using classroom, laboratory and on-the-job training, and simulator instruction. Classroom, laboratory, and simulator training is conducted by instructors from the training department of the power plant and specially prepared subject matter experts designated by the line sponsor of the training program. On-the-job training is conducted by trained and qualified incumbent members of the line organization sponsoring the training program. Training managers and training program owners evaluate the content and delivery of the training materials. Students in the training programs provide input on the timeliness, effectiveness, and relevance of the training materials to assist in improving training program content and delivery. Student mastery of learning objectives is assessed using written examinations and task performance evaluations (INPO, 1986).

As part of the Implementation phase, formative examinations are conducted throughout initial training programs to gauge program effectiveness and student mastery of the learning objectives. Students are remediated for their weaknesses and, when appropriate, reexamined to ensure they master critical program content. Task performance evaluations are conducted in the field under actual task performance conditions to ensure students have the ability to apply the knowledge they have gained in the training program.

Continuing training programs provide a combination of fundamental topic reviews and training designed to improve worker performance. In-plant performance problems are analyzed to determine if there are weaknesses in the knowledge and/or skills of the incumbents. When training is determined to be an appropriate intervention to improve performance, training material is developed to improve performance. These decisions are made by advisory committees composed of incumbent personnel, line managers, and training instructors and managers.

During the Evaluation phase of the systems approach to training, instructional programs undergo systematic formative assessments to determine effectiveness of the instruction and potential program improvements. Additionally, line and training program manager observations performed during the implementation phase are reviewed for trends and improvement opportunities. These evaluations are used to improve instructor performance and to ensure the training being delivered is technically accurate and focused on the needs of the training program sponsors. Most plants have developed systems of quantitative performance indicators to assist in ongoing assessment of training programs. Periodically, focused area self-assessments are conducted to assess training program effectiveness at meeting the objectives and criteria for accreditation renewal. Assessment results are reported to the Institute of Nuclear Power Operations as part of the Accreditation Self-Evaluation Report and reviewed by the National Nuclear Accrediting Board as part of the accreditation renewal process.

Training Program Management to Meet the Requirements of the Instructional Systems Design Process

One of the accreditation criteria is that the utility must demonstrate a linkage between the task analysis and the training materials used in the training programs. They must also demonstrate linkage between the learning materials sequenced into the materials and the evaluation instruments used to determine student mastery of the learning objectives. These relationships normally lead to complex matrices composed of several hundred tasks and several thousand learning objectives and test items to support an operator or technical training program. This has led to the development of complex hard copy or electronic data repositories to maintain these program components in a comprehensive and easily presented structure to meet accreditation requirements.

Maintenance of these matrices, and continued development of training programs, requires a high level of performance from the personnel in the training department of a nuclear power plant. As has been common with many areas of the workplace, instructors are required to provide increasingly higher performance to meet business goals. The role of the trainer has evolved in a manner similar to persons in other occupations. Over the last several years, the tasks many workers are required to perform in the workplace have become increasingly complex and less defined (Rosenberg, 1995). This is true in the nuclear training realm and the nuclear industry in general.

National Society for Programmed Instruction in 1962. This organization was later renamed the National Society for Performance and Instruction, and in 1995 became the International Society for Performance Improvement.

Practitioners of Human Performance Technology are commonly referred to as Performance Technologists (Brethower, 1998; Rosenberg, 1996). These practitioners perform systematic analyses of organizations to improve worker performance. Many of the practices of Human Performance Technology are similar to Instructional Systems Development methodologies. For this reason, in many organizations training departments are changing to performance improvement departments. Often, instructional designers are comfortable making the transition to performance consultant (ISPI, 1998; Ruckdeschel, Riveccio, Cortes, & Cookson, 1998; Sherry & Wilson, 1996), possibly, because they are comfortable with the role of observing workers in the workplace.

A typical model of the systematic practices used by Human Performance Technologists to design performance improvement systems is shown in Figure 1 (ISPI, 2002). Initially developed and published by Rosenberg, in Deterline and Rosenberg (1992, in ASTD 1996), this model has been refined over the last several years to its current configuration. The first step in Human Performance Technology is to perform a detailed performance analysis to determine the customers' requirements and the organization's mission, strategy, and goals. This analysis leads to the desired performance state the workers are to achieve. Next, performance technologists observe the workers to determine their current ability to perform the tasks, and the environment and organization in which the performance takes place. A gap analysis is conducted to

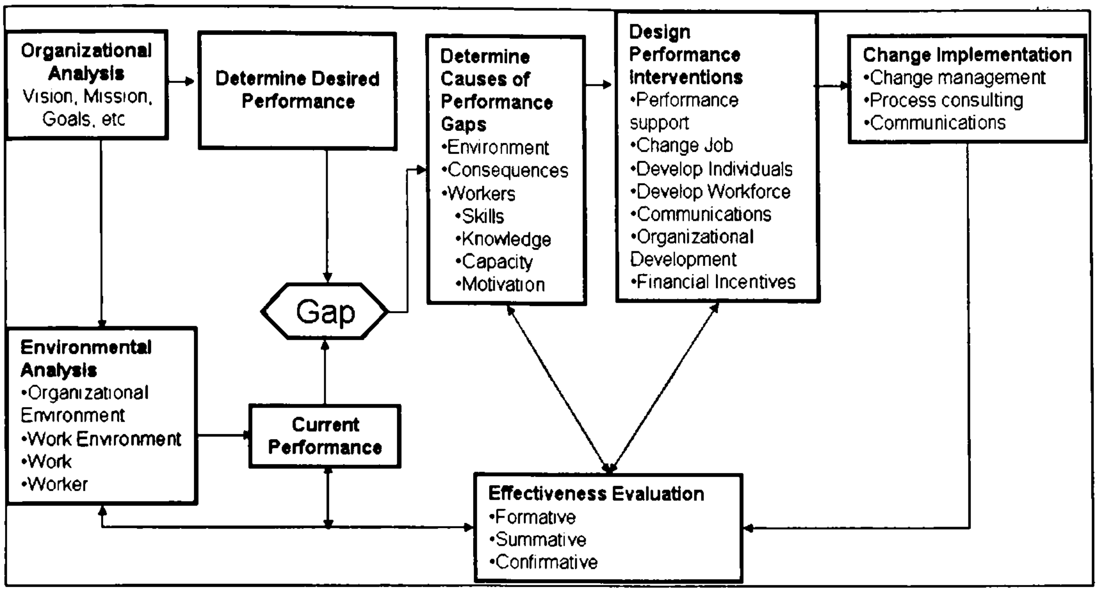

Figure 1. Human Performance Technology Model (Adapted from the International Society for Performance Improvement (2002))

determine the difference between desired and actual performance. Gaps in performance are analyzed and efforts made to determine their causes. Typical causes include lack of incentives to perform, insufficient data or information available to the worker to perform the task, inadequate or improper tools, lack of worker motivation, or low worker skills or knowledge (Kaufman; 1997; Rosenberg, 1995; Rosenberg, 1996).

Systematic approaches to improvement are used to select the most cost and performance-effective interventions for closing the gap between desired and actual performance. Human Performance Technology practitioners make extensive use of systems modeling, statistical measures, and applied psychological practices to ensure interventions are justified by measurable improvements in performance. Rosenberg (1996) indicated that Human Performance Technology interventions could be targeted on at least three functional areas in the organization.

First, the work—what can be changed about the job to make it easier for workers to accomplish? For instance, consider changing manufacturing practices or processes to improve productivity. Second, the workplace—what can be done to change people's jobs such as improving the working environment or the worker's quality of life? As an example, the company could provide additional hearing protection for workers in noisy environments to improve their concentration abilities. Third, the worker—what can be done to improve the worker? For example, replacing the worker with a different person or training the worker to perform more effectively (Rosenberg, 1996).

Effective interventions may be enacted at all levels of the nuclear organization. These interventions can be targeted at the Senior Reactor Operator who controls the output of the reactor to safely provide power to the nations power grid, to the operators on the job floor who monitor nuclear plant component operations, and finally to the support workers who provide maintenance of plant components and supply services to the organization. All of these constituents, and the engineers, managers, and supervisors who keep the processes moving, are part of the overall organization and system studied by the Human Performance Technology practitioner striving to improve the system. Examples of interventions selected include coaching, training, job aids, performance support, and improved documentation of how the job should be performed.

For many years, training and job aids have been the primary means of performance support in the nuclear training industry. The primary difference between training and the use of job aids is that training takes place in preparation for work and in preparation of the worker for the workplace. Job aids are used to supplement or replace training during the actual performance of work (Robbins, Doyle, Orandi, & Prokop, 1996; Rossett, 1996). Frequently, job aids are used when the tasks being performed are complex, when troubleshooting problems during maintenance, when tasks are not performed often, or when tasks are changed and the workers must alter their performance methods.

Electronic Performance Support System

Genesis and Description of Electronic Performance Support Systems

In the past several years, Electronic Performance Support Systems have become an increasingly common intervention recommended as a cost-effective alternative to additional instructor training in the development and management of nuclear training programs. An Electronic Performance Support System is a computer application that integrates traditional training development and delivery methods with software based support to improve performance. These systems provide a variable combination of skills training, task specific instruction, expert advice, and real-time on-the-job support to employees (Stevens & Stevens, 1996; Des Jardins & Davis, 1998; Rossett, 1996). The purpose of an Electronic Performance Support System is to improve worker performance and productivity using automated tools, sometimes called coaches, wizards, expert systems, or other task specific job-aids.

Electronic Performance Support Systems are designed to provide varying levels of performance support to the user, as required by the situation, during the performance of their work (Cole, et al., 1997; Rossett, 1996; Sleight, 1993). These levels are characterized as ranging from low, to medium, to high (Des Jardins & Davis, 1996), or possibly as minimal, to mid-level, to optimal (Sleight, 1993), based on the degree of support provided by the system. Des Jardins and Davis (1996) describe the three levels of support as follows:

> For example, if you are building a support system for accountants and you are providing automated tax form completion tools, the development time and cost is significantly different for each level. Will the tool be an off-the-shelf (low) representation, a company customized form for all accountants (medium), or is this an artificially intelligent, expert system form that knows the individual accountant's training, background, and areas on the form where the most support is needed (high).

Development of Electronic Performance Support Systems

Frequently, the Electronic Performance Support System is designed using a combination of instructional systems development and software development techniques. Systems resulting from this design emphasis are used to reduce the amount of traditional training time required to prepare a person to perform their work (Des Jardins & Davis, 1998; Rosenberg, 1998; Sleight, 1993). An Electronic Performance Support System is sometimes referred to as providing just-in-time training to the individual (Cole, et al., 1997). In other words, the Electronic Performance Support System allows the worker to learn while performing the task (Des Jardins & Davis, 1993; Desmarais, et al., 1997; Rossett, 1996).

Electronic Performance Support Systems are becoming increasingly more common in the workplace. A study sponsored by the American Society of Training and Development (Kemske, 1997) surveyed 638 users and developers of Electronic

Performance Support Systems regarding their current use, potential development, policies and perceptions, and development tools. The responses to this survey indicated that 87 percent of the users of Electronic Performance Support Systems considered them either somewhat important or vital to their job performance. When asked if they were considering developing additional Electronic Performance Support Systems in the next 18 months, 40 percent of the responders (243) indicated they planned to take from two to five projects past the proposal stage during that period.

Implementation Issues in Deploying Electronic Performance Support Systems

The cost of developing and implementing an Electronic Performance Support System is often quite consequential. Respondents to the Kemske survey (1997) sponsored by the American Society of Training and Development indicated the median expenditure for development of Electronic Performance Support Systems in their organization was $52,100 (411 responses), while their total expenditure for training was $202,400 (393 responses). Considering the number of projects estimated for development in the future, and the expense of the development process in relation to all training in the organization, it is important that these projects be implemented with the peak likelihood for success possible.

Studies conducted in the workplace have not found uniformly positive worker responses to the proliferation of computers and other technological advances. Bill (1993) concluded from a review of twenty-one other studies that attitudes toward new technology varied significantly between individuals. The most positive user reactions were those experienced when the individual felt a part of the innovation development.

Less positive reactions were experienced when the individual was unfamiliar with, or did not have an opportunity to become familiar with the innovation in a non-threatening environment. Resistance to technological change may be contributing to difficulties in implementing Electronic Performance Support Systems.

"Electronic Performance Support Systems have been heralded by some people as the wave of the future for employee training (Benson, 1997, p. 48)." However, Rossett (1996), stated that though Electronic Performance Support Systems' "desirable capacities should ensure that Electronic Performance Support Systems are revolutionizing the workplace (p. 574)," there were still many obstacles to attaining this outcome. Rossett further listed a number of reasons contributing to the slowness of proliferation including: lack of cross-functional coordination, interface frustration, lack of user preparedness, absence of an organizational infrastructure, absence of high-level ownership, cost of the Electronic Performance Support System, and resistance to innovation. Benson (1997) and Kemske (1997) described a lack of Electronic Performance Support System awareness and implementation cost as the two leading barriers to Electronic Performance Support System employment. Other common mistakes in developing and implementing Electronic Performance Support Systems include underestimating the time to develop the system, not testing the new systems adequately, and lack of a budget for maintenance and future support (Hall, 1996; Kemske, 1997).

In communications with Electronic Performance Support System developers, Gloria Gery (personal communication, December 19, 1998), a widely recognized author and developer of Electronic Performance Support Systems, listed several additional barriers to implementing Electronic Performance Support Systems. These barriers included: (1) presumptions that training should be the primary means of skill development, (2) information systems department perceptions that user participation in Electronic Performance Support System development will add time to projects—so they don't invite participation, (3) belief that programmers time is more important than that of the users of the system, control issues—who is in charge of the system, (4) lack of high-level sponsorship, and (5) focusing on the system performance/response rather than the worker's performance. Larry Harrison, another Electronic Performance Support System developer (personal communication, December 24, 1998), related a case describing significant resistance to development in one organization he had worked with. In this case, the root of the resistance was found that, in the past, travel had been associated with training. The workers were resisting giving up their opportunity for extensive, desirable travel.

Electronic Performance Support Systems in the Nuclear Training Industry

A recent nuclear industry survey of fourteen nuclear power plants indicated all of these plants are using some type of Electronic Performance Support System to support training management (Hayden, personal communication, March 26, 2001). These systems ranged from self-developed databases using commercial off the shelf software to custom made or commercially developed systems specifically designed for training management. Some of these systems are single station proprietary systems while one utility has networked their systems to provide management for ten nuclear stations in three states to support over eight thousand employees. Three of the responding utilities reported they were in the process of transitioning to a different Electronic Performance Support System at the time of the survey.

Corporate Culture

Background of the Study of Corporate Culture

The classical term of culture has a social anthropology basis (Kotter & Heskett, 1992) where it represents the qualities of specific human groups that are passed from generation to generation. Over the last several years, a division of culture study has been developed due to increased interest in organizational development (Van Muijen et al., 1999). Additionally, there has been a growing necessity to understand differing corporate cultures in view of increasingly common international competition between, or mergers of, corporate entities (Kotter & Heskett, 1992; Van Muijen et al., 1999; Hooijberg and Petrock, 1993).

Edgar Schein (1984) provided the following definition of organizational culture:

> Organizational culture is the pattern of basic assumptions that a given group has invented, discovered, or developed in learning to cope with its problems of external adaptation and internal integration, and that have worked well enough to be considered valid, and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems (p. 3).

He then presented his perceptions of three levels of culture—visible artifacts and creations, values, and basic assumptions. These three levels and their interactions, in the context of the nuclear industry, are demonstrated in Figure 2. The values portion of this definition provides a theoretical foundation for the cultural factors selected for this study.

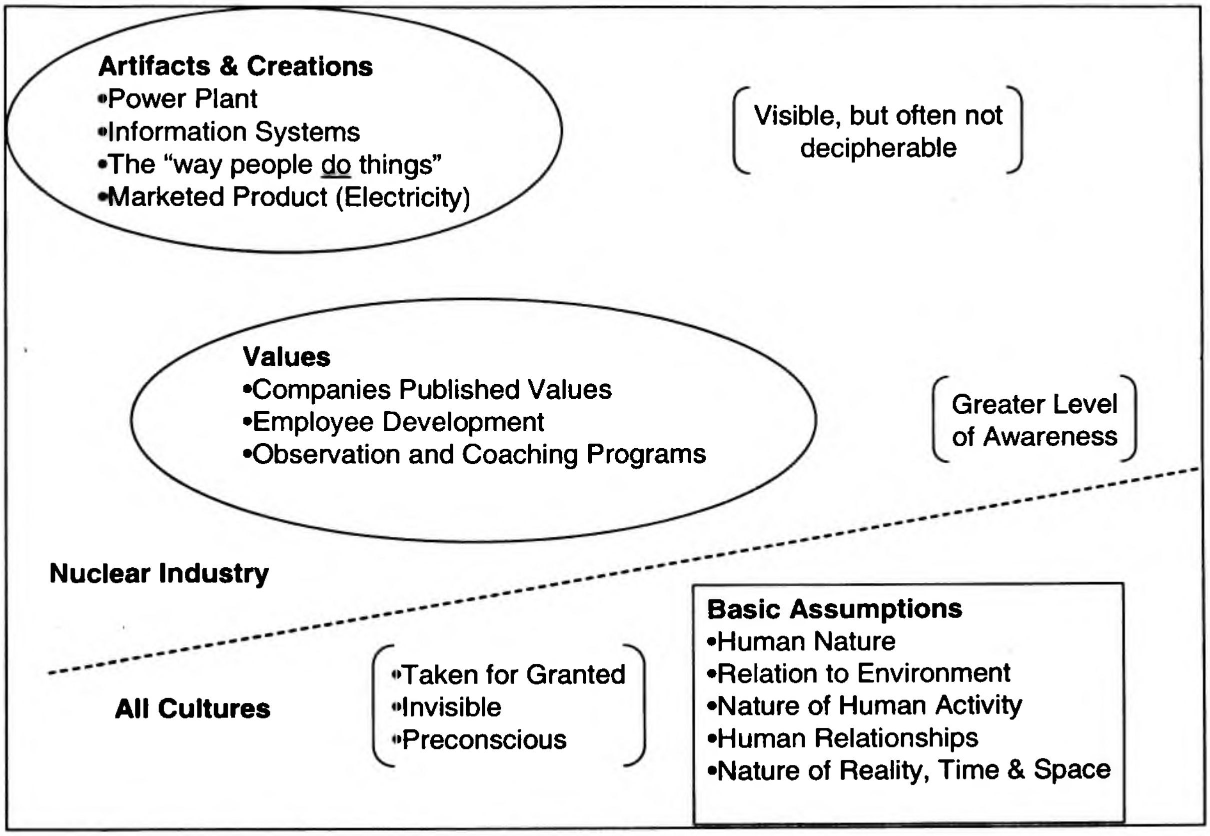

Figure 2. The Levels of Culture and Their Interactions (from Schein, 1984)

Many studies of organizational culture utilize hermeneutic research methods such as ethnography (Van Muijen et al., 1999; Steinhoff and Owens, 1989) and the collection and analysis of vignettes, stories, and verbal imagery (Steinhoff & Owens, 1989). The analysis of cultural information has been generalized in several taxonomies. Steinhoff and Owens (1989) describe organizational culture as a description of "the essence of the corporation itself" (p. 19). They provide a taxonomy of six dimensions to define school culture—history, values and beliefs, myths and stories explaining the organization, cultural norms, traditions, and the heroes and heroines of the organization. Stolp and Smith (1995) describe culture in schools in terms of three levels of culture—tangible artifacts, values and beliefs, and underlying assumptions. In describing corporate culture in the health care industry, Atchison (2002) relates corporate culture to human personality and uses an analogy of the values inculcated in children by their parents to the core values of an organization. Like children being raised by parents, new members of a corporate culture learn consistent behaviors that follow the corporate values. Through the observation of individual's behaviors in the organization, we can make inferences to the culture of the organization.

Many studies of organizational culture have been related to the strength of the culture and organizational effectiveness (Atchison, 2002; Schein, 1984, 1988). Many of these studies used factor analysis to determine variables correlating to effective organizations. However, the results of the analyses tended to vary from one study to another. In 1988, Robert Quinn was conducting research into organizational effectiveness and concluded when the factors of several studies were reanalyzed using more advance techniques (multi-dimensional scaling); a theoretical framework to facilitate quantitative analyses of organizational culture was derived.

The framework presented by Quinn (1988) and further explained by Cameron and Quinn (1999) is the Competing Values Model consisting of two intersecting axes creating four quadrants. The vertical axis is related to the level of control within the organization from flexible to controlled, while the horizontal axis expresses the focus of the organization—from internal to external focus. Intersection of the two axes provides four quadrants, each representing an organizational culture model. Each of the quadrants is then related to two criteria within their respective organizational model. The organizational models and criteria are depicted in Figure 3.

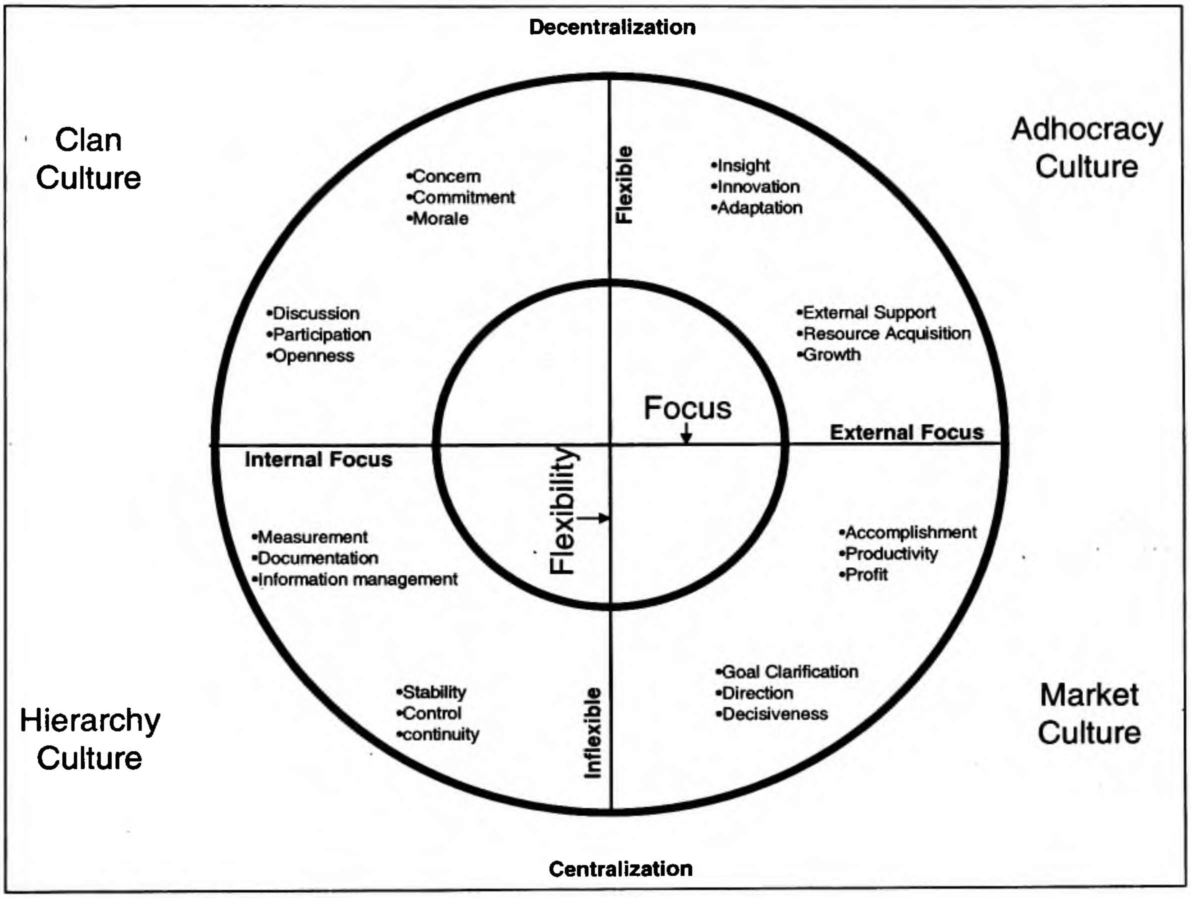

Figure 3. The Competing Values Model (from Quinn, 1988)

The model is called the Competing Values Model because of the relationship of the traits in each culture type. Traits have an opposing attribute in the diametrically opposed quadrant. An assumption made when producing this model is that value systems in opposing cultures are generally contra-cultures with value systems in opposition when related to the basic attributes of focus and flexibility. The degree of opposition provides an indication of the strength of the predominant culture of the organization.

Types of Corporate Culture.

The competing values model provides four types of corporate culture—Clan, Adhocracy, Hierarchy, and Market. Each of these cultures has specific value attributes that can be measured using quantitative methods (Hooijberg and Petrock, 1993; Howard, 1998; Quinn, 1988; Van Muijen et al., 1999). Descriptions of the four culture types with their accompanying traits are provided in the following paragraphs

Hierarchy (Internal Process Model)

Howard (1998) labels this culture type as Internal Process with formalized communications and centralized decision making as the values for control and internal focus. Other researchers describe this culture as the Hierarchy. Hierarchical cultures provide formalized structure in the workplace. The work is controlled by procedures and managers provide coordination to ensure smooth and consistent operations. The organization values stability with efficiency (Hooijberg & Petrock, 1993). Quinn (1988) uses the terms of measurement, documentation, information management, stability, control, and continuity to define the values of a hierarchal culture.

Adhocracy (Open Systems Model)

Quinn (1988) presents the Adhocracy culture as an Open Systems Model having traits of insight, innovation, and adaptation, coupled with external support, resource acquisitions, and growth. Hooijberg and Petrock (1993, p. 31) describe an Adhocracy "as a dynamic, entrepreneurial, and creative place to work." The adhocracy is externally focused and flexible in its endeavors (Hooijberg & Petrock, 1993; Howard, 1998; Quinn, 1988).

Firm (Rational Goal Model)

Firm cultures are characterized by the Rational Process Model. Characteristics include goal clarification, Direction, decisiveness, along with values of accomplishment, productivity, and profit/impact (Hooijberg & Petrock, 1993; Howard, 1998; Quinn, 1988). Hooijberg and Petrock also describe this as the Market or Enterprise culture with an organizational style that values "hard-driving competitiveness (1993, p. 31)."

Team (Human Relations Model)

The team culture values concern for people, commitment, and morale. These values exist alongside discussion, participation, and openness (Quinn, 1988). The development of human resources is important and the organization is described as being held together by loyalty or tradition, in a manner similar to a family, with leaders acting as mentors (Hooijberg & Petrock, 1993). For this reason, it is also described as the Clan culture (Petrock, 2002).

While the competing values framework demonstrates the cultures as opposing in nature, organizations seldom fall into only one quadrant of the framework (Hooijberg & Petrock, 1993; Howard, 1998; Quinn, 1988). Cultural attributes of adjoining cultures share some parallels in values or behaviors while those of diametric cultures are generally in opposition to each other. Therefore, organizations tend to fall into a mixture of cultures based on the strength of individual attributes or behaviors (Hooijberg & Petrock, 1993; Howard, 1998; Quinn, 1988). Schein (1984, 1996) maintains that competing and/or complementing sub-cultures exist within an organization. In addition, organizations change their cultures over time based on external and internal needs

(Schein, 1984, 1996; Hooijberg and Petrock, 1993; Kotter & Heskett, 1992). However, while cultures may change, the changes are generally not accomplished rapidly, are sometimes subtle in nature, and frequently do not last due to the static nature of corporate culture. This is particularly true in strong cultures where the underlying values are strongly inculcated in the organization (Kotter & Heskett, 1992; Kotter, 1996; Schein, 1984, 1996).

Instruments for Determining Corporate Culture

Over the last two decades, the emphasis on developing quantitative methods to determine corporate culture has increased (Howard, 1998; Van Muijen et al., 1999). Several studies have focused on establishing the validity of the competing values model as a means of reflecting the values of an organization and relating this to corporate culture. It has been theorized that knowing the values of the organization will assist in planning reengineering projects to improve corporate competitiveness (Hooijberg and Petrock, 1993; Howard, 1988; Petrock, 2002; Schein, 1984, 1996). While the instruments are not identical, several researchers have developed corporate culture determination instruments based on the competing values framework.

Van Muijen et al. (1999), as part of an internationally sponsored research group known as the FOCUS Group, developed the FOCUS questionnaire based on the competing values framework. The FOCUS Questionnaire began as a 250-item questionnaire with 125 items as descriptive terms directly measuring observable behaviors, procedures, or policies (artifacts). The other 125 items measured the perceptions of organization members related to underlying values. These items were evaluated by a panel of 12 expert members of the group and 128 items were selected for a pilot study. Factor analysis was conducted on the responses to this survey and the FOCUS Questionnaire was subsequently refined through two subsequent administrations to a survey consisting of 40 descriptive and 35 value-characteristic items. While Mokken analyses indicates the instrument is reliable (Cronbach's alpha >.70 on seven of eight scales), limitations were presented related to using a single instrument in a multi-national study.

Howard used the Organizational Culture Profile developed by Chatman (as cited in Howard, 1998) as the basis for a study using Q-sort and Multidimensional Scaling Analyses. A group of 58 value statements was submitted to a group of 29 academic experts in the area of organizational culture. Based on the results of this content validation, 48 items were provided to the participants in the study to sort the value statement in terms of how well they described their specific organizations. Analyses of the results of these responses using Multidimensional Scaling indicated a relationship between the respondent's characterization of their organizations and the competing values framework. When the values provided by the respondents were analyzed and related to the axes of the competing values framework, the strongest relative dimensional weights were in the vertical axis (Control versus Innovation (flexibility) of 2.14 and -2.45 respectively) and a weaker weighted value was indicated in the internal (Teamwork = -.81) versus external (Outcome—1.06) focus attributes of the framework. While the small sample size placed limitations on the generalizability of Howard's conclusions in the study, Howard's research provides additional indication that the competing values model provides a valid framework for the understanding of organizational culture.

Frank Petrock (2002) uses the competing values model in his role as a consultant for organizational change and business process reengineering. The instruments used in his work have been field tested while consulting with such firms as AT&T, Ford, TRW, General Motors, and numerous others. He has also provided consulting services to several nuclear industries including Babcock & Wilcox, a major component supplier in the industry. Babcock & Wilcox was required to complete a major reengineering of their business processes to meet significant changes in the demand for nuclear components in the 1980's. As part of their reengineering process, Dr. Petrock provided assistance in determining their current culture using the Current Culture Survey (Hooijberg & Petrock, 1993). Using the competing values model attributes, it was determined the company was currently exhibiting primarily Hierarchy and Clan culture behaviors. This combination of cultures had facilitated the company to become bound to less than effective procedures and business processes (Hierarchy), while also allowing their Clan culture to create an insular silo effect between business units within the organization. By determining their current culture, it became possible for them to develop interventions that facilitating their transition to a more Adhocracy and Market oriented culture. This shifted their orientations to behaviors that are more flexible and a more externally focused organization.

Another application of the competing values model to change a corporate culture was in the case of the Davis-Besse nuclear power plant. Davis-Besse also used the current culture survey and combined this with a complementary instrument developed by Petrock, the Desired Culture Survey (Petrock, 2002). The combination of the results of these surveys facilitated Davis-Besse in developing implementation strategies to transition from a primarily Market-Hierarchy culture to a more balanced culture with an increased human resources focus and an Adhocracy with more innovation and increased external focus.

While the instruments used by Petrock have not undergone quantitative analysis to determine their validity and reliability, there is significant qualitative evidence they are successful in facilitating implementation of organizational change efforts through the determination of existing and desired corporate culture(s). Such qualitative evidence related to the study of organizational culture is considered a significant positive by such experts as Edgar Schein (1984, 1996). Petrock uses a strategy of action research, combining surveys, interviews, and direct liaison with corporate leadership, when recommending performance interventions. Having been used successfully in consulting with eight nuclear power stations, there is strong indication this methodology will provide results that may be generalizable to other nuclear power stations such as will be observed in this study. There is also anecdotal evidence of the transferability of the methodology to other industries based on his work with non-nuclear industries. Transferability and generalizability are two indications of the "Criteria of Soundness" (Marshall & Rossman, 1995, p. 143) indicating a valid qualitative research methodology.

This study utilizes the Organizational Culture Assessment Instrument developed by Robert Quinn and Kim S. Cameron (1999) to determine the organizational culture of the participating training departments. This instrument has been used in numerous studies of corporate culture with established reliability and validity measures. A study was conducted by Quinn and Spreitzer (1991) (in Cameron & Quinn, 1999) with the participation of executives from 86 firms. Cronbach's alpha coefficients were calculated for the four culture types presented in the Competing Values Framework. The researchers reported the coefficients were statistically significant with .74 for the clan culture, .79 for the adhocracy culture, .73 for the hierarchy culture, and .71 for the market culture. Another study using the Organizational Culture Assessment Instrument was conducted by Yeung, Brockbank, and Ulrich (1991) (in Cameron & Quinn, 1999) With over 10,000 respondents in 1,064 businesses, the researchers reported satisfactory reliability coefficients of .79 for the clan culture, .80 for the adhocracy, .76 for the hierarchy, and .77 for the market culture. A third study presented by Cameron and Quinn (1999) was performed by Zammato and Krakower in 1991(in Cameron & Quinn, 1999). In this study, over 1300 respondents completed the instrument with reliability coefficients of .82 for the clan culture, .83 for the adhocracy, .67 for the hierarchy, and .78 for the market culture.

Validity for the Organizational Culture Assessment Instrument was presented by Cameron and Freeman (1991) (in Cameron and Quinn, 1999). In this study, 334 institutions of higher learning used the instrument to identify organizational cultures. All four of the cultures were demonstrated to some extent in the study. In addition, no organization was depicted as having a single culture type. Additional measures were made of indicators of organizational effectiveness in the participating higher education institutions. Analyses of the characteristics of organizational effectiveness were compared to the elements of the competing values framework. These analyses indicated strong evidence of concurrent validity in the instrument. Additional studies presented by Cameron and Quinn (1999) indicated both convergent and discriminant validity for the instrument "using a multitrait-multimethod analysis and a multidimensional scaling analysis (Cameron & Quinn, 1999, p. 142)."

There were three primary reasons for using the Organizational Culture Assessment Instrument in this study. First, the demonstrated ability to determine corporate culture (validity). Second, the documented reliability of the instrument in previous studies. Finally, the availability of the survey for use in this study (cost) was a factor in its selection.

Relationships between Corporate Culture and Resistance to Change

Corporate cultures are normally developed over long periods and have been brought about through the development of strategies that provide success (Kotter and Heskett, 1992). Referring to Schein's (1984) definition of organizational culture, the values and basic assumptions of the group have been successful to the point where they are taught to new members as the correct way to think and act. Quinn (1988) describes the need for organizations to understand their culture and for managers to be able to motivate their organizations to exhibit the appropriate cultural attributes for their situation. He does not postulate there is any one specific correct corporate culture. The most effective organizations may need to move between and exhibit traits of any or all of the four cultures.

Hooijberg and Petrock (1993), when presenting how to use the competing values framework to promote change strategy, describe long standing cultures as being hard to change even when the survival of the organization is at stake. Schein (1984) describes cultures as moving through phases over time. During the inception phases, culture provides a basis for the young culture to grow. During the middle portion of the organizational development, the culture becomes strong, that is, it learns to adapt to new situations. Members of the organization provide lessons learned to new members to maintain the organization. Organizations that reach maturity learn to adapt to the changing environment around them (globalization, reengineering, environmental concerns, etc.) or they may succumb to the trap of stagnation and subsequently fail.

By understanding the stages and attributes of corporate culture, managers can facilitate change in the culture when required (Hooijberg and Petrock, 1993; Kotter, 1996; Kotter and Heskett, 1992; Quinn, 1988; Schein, 1984, 1996). The nuclear industry is currently undergoing a period of significant change to meet a changing economic and regulatory environment. These changes started with the events at Three Mile Island in 1979 and have continued through a current period of transition from regulated public utilities to a market driven, competitive business environment (Institute of Nuclear Power Operations, 2002). With this increased emphasis on organizational effectiveness, the industry is embracing a need for culture change to improve competitiveness. Understanding how organizational culture relates to effectively implementing performance support systems such as an Electronic Performance Support System to support training management may assist the industry in making this transition.

Summary

There is currently a movement in the nuclear industry to use Electronic Performance Support Systems as a means of performance improvement in the workplace (Jenco, 2002). As the complexity of current training programs increases and the standards that utilities must achieve to maintain their accreditation raise, the use of an Electronic Performance Support System to support training program management has become increasingly common. The costs of implementing and maintaining these programs are becoming a significant portion of the training budget.

While there is evidence that Electronic Performance Support Systems are a viable method for improving performance, a review of the available literature indicates there is little evidence available that these systems are being implemented in the most effective manner possible. Human Performance Technology practices require that interventions selected to improve performance be the most cost effective and have the highest probability of success at closing performance gaps (Stolovich & Keeps, 1999). It is not evident from the current state of the research that information related to the probable barriers that can be encountered while implementing an Electronic Performance Support System are available for practitioners and managers to make business decisions.

Information related to barriers to successful implementation of Electronic Performance Support System is primarily anecdotal. Therefore, it is important that additional research be conducted in this area. Quantifiable and current information is required to support development of successful implementation strategies for Electronic Performance Support Systems. As corporate culture can play a significant part in organizational change, concurrent investigation into the relationships between corporate culture and barriers to the effective implementation of Electronic Performance Support Systems could provide valuable information for training managers making implementation decisions in this topic.

This review of literature focused on three major areas. The first area was the nuclear industry including: (1) nuclear industry background and requirements in the law for the accreditation of nuclear training programs; (2) development of nuclear training programs and the methodology for accreditation of program accreditation; and, (3) application of the systematic approach to training and its relationship to instructional systems development. Second was the field of human performance technology, including: (1) a review of the development of the practice of human performance technology and its relationship and use in training; and, (2) development of Electronic Performance Support Systems as a means of supplementing traditional training programs to improve workplace performance, and, (3) frequently encountered barriers to implementation of Electronic Performance Support Systems. Corporate culture was reviewed in the third section, including: (1) definition of corporate culture, (2) types of organizational cultures, and (3) attributes of corporate culture that will provide the factors analyzed in this study. Relationships between these areas provide a foundation for this study. Proposed instruments and analysis techniques used in this study were reviewed in the last section.

Chapter 3

RESEARCH METHODOLOGY

This chapter includes the survey instrument formulated from a literature review and consultation with experts in Electronic Performance Support System development and implementation. The survey was reviewed by the dissertation committee and a group of volunteers solicited from members of the nuclear training industry. Resulting comments were incorporated to improve readability and content validity. Also provided are the procedures for the study and the methods for compilation of the analyses.

Measurement Instruments

The measurement instrument for this study consisted of four parts as shown in Appendix A. As an Explanatory Survey (Calder, 1998), the purpose of the survey is to determine if various barriers to effective implementation of Electronic Performance Support Systems may be correlated with the presence of certain organizational culture traits in the responding organization. Survey research was selected for this study as the most time efficient and financially feasible means of data collection (Calder, 1998). The Educational And Industrial Testing Services (Isaac & Michael, 1995) recommends surveys designed for educational purposes have the following characteristics—(1) be systematic in nature, (2) solicit responses from a sample closely representing the population being studied, (3) provide objective data for analyses, and (4) provide results that may be presented in a quantitative manner. The design of the instrument, selection of the sample, and analyses techniques proposed were formulated to satisfy these characteristics.

Part One of the instrument collects common demographic information such as the position of the respondents in the organization, size of the organization (single or multi-site), and whether the Electronic Performance Support System being rated was internally or externally developed and/or implemented. Respondents were asked to provide their responses related to their experience with implementation of an Electronic Performance Support System. This portion of the survey is based on descriptions of typical nuclear utilities as described by the Institute of Nuclear Power Operations and the literature review related to potential implementation barriers.

Section Two of the questionnaire solicited the respondents' perceptions of barriers to effective Electronic Performance Support Systems implementation. The barriers rated were determined from a review of the literature and input from Electronic Performance Support System development experts. Content validity of this portion of the survey was established through a comparison of barriers presented in the literature review (Fink, 1995). Face validity was established by a peer review of the instrument prior to administration. This section of the questionnaire is a multi-part Likert scale. Participants were asked to rate common barriers according to three criteria—Frequency of encountering the barrier (1—very infrequent to 5—very frequent); Impact on implementation (1—very low impact to 5 very high impact); and Importance in overcoming the barrier (1—very low to 5—very high importance).

Responders were requested to provide their perceptions of the overall effectiveness of their Electronic Performance Support System implementation projects in the Third Section of the survey. Such areas as satisfaction with performance of the system, plans to conduct similar endeavors in the future, and perceptions of user effectiveness in improving workplace performance were requested. This portion of the survey provides indication of the results of previous Electronic Performance Support System implementation projects. Satisfaction with previous projects and perceptions of willingness to continue with future development projects provide additional indication of the value of the study in future training program improvement projects.

The final portion of the instrument requested respondents to provide responses related to their current organizational culture. This portion of the survey was based on the Organizational Culture Assessment Instrument (Cameron & Quinn, 1999, with permission). Respondents were guaranteed their responses to this and other portions of the instrument will remain confidential and used only in the context of summary data. A copy of the letter requesting participation in the study is provided in Appendix B.

The instrument was pre-tested by a group of nuclear training professionals from the Exelon Nuclear Corporation. This pre-testing was used to evaluate the instrument for readability, interpretation variance, and general impressions on the applicability of the survey to the needs of the industry (Calder, 1998; Isaac & Michael, 1995; Krosnick, 1999). The Exelon Nuclear Corporation is one of the largest nuclear utilities in the United States and has significant experience in implementing Electronic Performance

Support System to support training programs. This selection was made because Exelon is typical of the industry and readily accessible to the researcher.

Population and Sample

The population for this study included instructors, instructional technologists (since they provide a significant source of expertise in the systems approach to training and accreditation requirements), database administrators (persons in each organization responsible for maintaining current or projected electronic training information repositories), and three levels of training managers at nuclear power plants. There are currently one hundred and three licensed commercial nuclear reactors in the United States. These reactors are distributed in 63 single or multi-reactor sites. The Institute of Nuclear Power Operations maintains a contact list of the Training Managers at each of the licensed facilities for benchmarking purposes. The nuclear industry views benchmarking and sharing of information between nuclear utilities as a positive and effective means of performance improvement (Institute of Nuclear Power Operations, 2002).

The sample for this study was voluntary respondents from the population described above at all commercial nuclear facilities in the United States. The survey was provided to 63 nuclear power plants and 7 corporate nuclear utility training offices. Each organization was requested to provide four or more individual responses. This provided a potential sample of 280 or more respondents for analysis if all utilities participated to the maximum extent requested by the researcher. The minimum sample size recommended for Exploratory Factor Analysis is "5-10 times the number of observed indicators."

(Grimm & Yarnold, 2001, p. 117). The survey under development in this study includes four cultural types and twenty-five implementation barriers. Depending on the number of individual factors determined from analysis, the sample size for the survey should be sufficient to provide sufficient reliability for the generation of conclusions and recommendations. The potential error of having too few respondents for analysis of mean differences in the factor analysis would be a Type II error where there is no indication of correlation where one actually exists (Grimm & Yarnold, 2001).

Data Collection Methods

The survey was provided to the Training Directors at all nuclear utilities in the United States in the form of a mail-delivered, self-administered questionnaire. A letter describing the purpose of the study and requesting participation introduced the survey to improve the response rate (see Appendix B). It has been shown that an introductory letter relating the relevance of a questionnaire to the respondents can improve response rates (Calder, 1998; Isaac & Michael, 1995). Respondents were requested to provide responses within thirty days of receipt of the survey. Self-addressed, stamped envelopes were provided for the return of the questionnaires and for additional information if the utility requested. A follow-up e-mail was sent to the Training Directors two weeks after the initial delivery. An additional e-mail including an electronic version of the survey instrument was sent one week after the requested return date to facilitate responses from the maximum number of recipients possible. In addition to direct communication with the Training Directors at the utility, where contact information was available, a parallel communication was sent to the Instructional Technologists at the utilities requesting assistance in providing responses. The principal investigator in this study is a member of a working group comprised of Instructional Technologists and these contacts assisted in promoting the timely return of questionnaires.

Two weeks after the due date for responses, a final e-mail was sent to the Training Director at the utility as a final solicitation to participate in the study. These follow-up techniques were used to maximize the number of respondents and minimize the effect on reliability and generalizability due to non-responders (Calder, 1998; Isaac & Michael, 1995; Krosnick, 1999). All communications reinforced the voluntary nature of the respondents' participation in the study.

Data Analysis

Cronbach's Coefficient Alpha, generally accepted as a test for internal consistency, was used to determine instrument reliability. Separate analyses were determined for barriers related to Frequency, Impact, and Importance. Descriptive statistics including means (factor and individual) and standard deviations were determined for each item in the questionnaire.

Both Exploratory and Confirmatory Factor Analysis have been used in previous studies to analyze the relationships between the values and behavioral factors and specific culture types in previous research (Hee-Jae, 2000). This survey used Exploratory Factor Analysis to determine statistically significant implementation barriers. While Confirmatory Factor Analysis was considered, it was determined to be inappropriate in this study due to the size of the population sample related to the number of factors being analyzed (Grimm & Yarnold, 2001).

Exploratory Factor Analysis was conducted on the response data leading to the clustering of the items into relevant factors. Individual analyses were conducted for each of the response scales of Frequency, Impact, and Importance. Statistically significant factors were explored for their underlying components to establish a reasonable factor structure. Using this underlying clustering of barriers, the factors were then recoded, using the mean values of the component barriers, to create new individual barriers representing the factors in each attribute. These new barriers were then used in the subsequent correlation analyses with corporate culture analysis results and demographic factors.

A Correlation Matrix (Pearson Product-Moment) was constructed to determine if demographic traits indicated a statistically significant correlation to the factors determined from the participant's responses. This Correlation Matrix was also used to determine correlations between barriers and corporate culture. Questionnaire responses were evaluated for statistically significant differences at the $\rho < .05$ level of significance. To reduce the potential for Type I error, a Bonferroni adjustment was utilized to adjust the alpha levels for those barriers that were used in multiple analyses (Huck & Cormier, 1996). Additionally, Crosstabs (also utilizing a Bonferroni correction factor) were constructed to investigate any other possible relationships between the barriers, demographic traits, and corporate culture.

Analysis of Variance (ANOVA) was used to determine if there were any statistically significant differences in the respondent's perceptions of overall satisfaction with the Electronic Performance Support System implemented at their organization. The one-way ANOVA constructed utilized a Bonferroni correction factor to adjust for multiple analyses of the same data set. Results were reported at the $\rho < .05$ level of significance.

Respondents provided their responses with anonymity, and returned surveys were not identifiable to either individual or utility. These measures ensured the confidentiality of the respondents' information. University Institutional Review Board Guidelines were followed and respondents were provided a contact at the university to address any possible concerns with participation. None of the respondents used this option.

The results of the analyses are presented in Chapter 4. Conclusions based on the analyses are presented in the last chapter of this study. A summary of the results will be presented at nuclear industry training management meetings for consideration in future Electronic Performance Support System implementation projects.

Chapter 4

DATA ANALYSES RESULTS

The results of this study will be delineated in this chapter. Specifics addressed include participants, data collection, statistical analyses of the survey instrument, and demographic comparisons. A summary will conclude this chapter.

Participants

Nuclear station and corporate training directors (N = 70) were invited to participate in this study. Invitations to participate included a description of the study, the purpose of the study, instructions for administration of the survey, and five copies of the instrument for completion. Each director was requested to have at least four persons from their organization, including themselves, complete the instrument, and return it to the principal researcher (N = 280). Persons requested to complete the survey were training directors, training managers, training program lead instructors, Electronic Performance Support System developers, database administrators, instructional technologists, and instructors. The demographics of the persons responding to the survey are provided in Table 1.

Table 1

Demographics of Survey Participants

Role Of Respondent	Respondent From Multi-Site Utilities		Respondents From Single-Site Utilities		Respondents From All Utilities	
	N	%	N	%	N	%
Managers						
Training Director or Manager	14	28%	3	20%	17	26.15%
Department Manager or Supervisor	10	20%	4	26.67%	14	21.54%
Program Lead Instructor	3	6%	5	33.33%	8	12.31%
Subtotal	27	54%	12	80%	39	60%
Individual Contributors						
EPSS Developer	2	4%			2	3.08%
Database Administrator	8	16%	1	6.67%	9	13.85%
Instructional Technologist	9	18%			9	13.85%
Instructor	4	8%	2	13.33%	6	9.23%
Subtotal	23	46%	3	20%	26	40%
Total	50	76.92%	15	23.08%	65	

Overall, 60% of the respondents were training program managers and 40% were non-supervisory members of their training departments. Of the respondents, 77% were from multi-site utilities and 23% were from single-site utilities. The nuclear industry is currently comprised of 65 nuclear stations with 48 (73.8%) multi-site and 17 (26.2%) single-site utilities. A typical training department in the nuclear industry consists of a Training Director, three Department Managers, six Program Lead Instructors, a Database Administrator, two Instructional Technologists, and 28 Instructors. This equates to a 26.6% (20 of 70) return rate from utilities or corporate training offices, and an individual return rate of 23.2% (65 of 280).

Data Collection

Pre-addressed stamped envelopes were provided for return of the packages from each of the utilities. Survey packages were received from the participating respondents during the period from August 17, 2002 - September 23, 2002. Sixty-five useable surveys were returned and manually entered into a statistical package for analysis. Statistical analyses were performed via the Statistical Package for the Social Sciences (SPSS, Inc., 1989-2001).

Data Analysis

The purpose of this study was to determine if there are relationships between organizational culture factors and commonly encountered barriers to implementing Electronic Performance Support Systems. Initial data analyses focused on internal consistency and factor loadings. Demographic and culture correlations were analyzed via a correlation matrix (Pearson Product-Moment). Descriptive statistics including Number of Responses, Means, and Standard Deviations for the responses related to barriers investigated in the instrument are provided in Appendix C, Table C1.

Reliability of the Instrument

To determine the internal consistency, or reliability of the instrument, Cronbach's alpha was used. While other measures may be used for this purpose, Cronbach's alpha is appropriate for use where the items are scored with three or more possible responses (Huck & Cormier, 1996). Internal consistency reliability for this instrument was conducted in two parts. Since barriers to effective implementation of Electronic Performance Support Systems and corporate culture are measures of two different constructs, alphas were determined separately for each part of the instrument.

Twenty-five barriers to effective implementation to Electronic Performance Support Systems were rated by the respondents in relation to three separate attributes—Frequency, Impact, and Importance. Descriptive statistics for these barriers are provided in Appendix C, Table C1. A summary of the reliabilities for the attributes were determined for each of these areas with the results provided in Table 2.

Table 2

Summary of Coefficient Alpha Reliability for Barriers (N = 25)

Attribute	N	M	SD	Reliability (α)
Frequency	65	78.0192	14.8132	.9068
Impact	65	82.1494	13.7627	.8993
Importance	65	87.2951	9.3315	.7815

As can be seen in Table 2, these coefficients ranged from .7815 to .9068. Reliabilities for the attributes of Frequency, Impact, and Importance are provided in Appendix C, Tables C3 through C5 respectively. According to Nunnally (1988), values of alpha above .70 are acceptable for reliability.

Factor Structure

The factor structure of the barriers to implementation portion of the instrument in this study was examined using the principal components analysis model in SPSS. The data summarization resulting from factor analysis was chosen to reduce the number of barriers to be used in later analyses related to organizational culture. Since the purpose of this study was to determine if there are significant relationships between implementation barriers and corporate culture in order to improve management effectiveness in implementation of Electronic Performance Support Systems, providing a reliable, yet manageable list of attributes for the use of managers was desired. Using factor analysis to reduce the list of barriers is a primary function of Factor Analysis (Grimm and Yarnold, 2001; Hair et al., 1998).

The first step in the factor analysis was to review the data for missing responses. This review indicated that approximately 2.61 percent of the responses had missing values (124 of 4751) among the 25 barriers analyzed in the factor analysis. The missing data were mixed throughout the dataset. The option to replace missing variables with the response mean value was used in the data analyses using SPSS. This is an accepted method for providing a value for missing observations (Hair et al., 1998). While another potential method of dealing with missing data would have been to ignore missing data in subsequent calculations, this methodology was not used in this study due to the sample size for this study.

Barriers were described by the participants in this study using three separate attributes - Frequency, Impact, and Importance. Due to the unique structure of each of these attributes, separate factor analysis was performed on each attribute. Subsequently, a Varimax rotation was conducted to provide "clearer separation of the factors (Hair et al., 1998, p. 110)."

Based on the population size for the factor analyses, a threshold of .6 was chosen for the determination of scale items that are included in the factor model. Grimm and Yarnold (2001) recommend a minimum of 100 subjects for factor analysis and a minimum ratio of five subjects to each variable to ensure reliability of the analyses. Hair et al. (1998) recommends a minimum sample size of 50 observations with a recommended number of 100 and a subject to variable ratio of at least five-to-one. However, Hair et al. (1998) provide recommendations for the use of additional measures to improve the reliability of Factor analyses performed with small sample sizes. For sample sizes between 50 and 70 observations, Factor Loadings of between .65 and .75 are recommended for extracting factors. Additionally, Hair et al. (1998) recommend lowering the acceptable threshold for acceptable Factor Loadings as the number of variables increases. Based on these recommendations, a threshold of .6 was chosen for extraction of factors in this study. This threshold was chosen to ensure acceptable reliability while minimizing the potential for Type-2 error.

The overall significance of the correlation matrices derived in the Factor analyses were assessed using the Bartlett Test of Sphericity and Measure of Sampling Adequacy (MSA). These tests are used to determine the appropriateness of Factor Analysis as an analysis tool (Hair et al., 1998). A generally accepted minimum value for both the measure of sampling adequacy and Bartlett's Test of Sphericity is .5. Based on initial analyses of each barrier set, barriers were removed from the factor analyses that did not meet these thresholds. Additional Factor Analyses were then conducted on the revised barrier sets until the measure of sampling adequacy for all individual barriers were greater than .5. The final values for Bartlett's Test of Sphericity were greater than .5 in each of the three attributes. These values indicate the barrier sets could be appropriately analyzed using Factor Analysis.

Frequency of Barrier Occurrence Factor Analysis Results

The first analysis was to determine if factors for the attribute of Frequency of barrier occurrence were evident. The first iteration of this analysis indicated there was one barrier (BARR13_1 - Users felt that training should be the primary means of skill development (Freq)) which did not have an adequate measure of sampling adequacy for retention (MSA = .432). This barrier was removed from the subsequent analysis resulting in MSA being greater than .5 for all retained barriers.

Various iterations of the factor analysis for Frequency, with the number of factors ranging from three to seven, were conducted to determine the factors providing the most statistically and practically significant number of factors. The result was selection of a factor analysis clustered into five rotated factors accounting for 60.995% of the variance.

Scale items with values greater than .6 were selected as significant components of the resulting factors. The final rotated component matrix is as shown in Table 3.

Table 3

Rotated Component Matrix—Frequency

60.995% of Variance accounted for in 5 Factors (14 Barriers)

			Component				
Factor Name	Barrier	Percent of Variance / Cumulative Percent	1	2	3	4	5
Cost considerations	BARR14_1 Developers thought participation by end users would extend development time (Freq)	32.725 / 32.725	**.765**	.126	.165	6.283 E-02	.262
	BARR7F_1 Unexpected cost increases (Freq)		**.684**	-8.547 E-02	.170	.219	-2.368 E-02
	BARR12_1 Lack of budget for future maintenance and support (Freq)		**.671**	.152	.284	6.371 E-02	-4.554 E-02
	BARR17_1 Focus on system performance rather than on user performance improvement (Freq)		**.640**	.318	.163	.126	-.289

Factor Name	Barrier	Percent of Variance / Cumulative Percent	Component 1	2	3	4	5
	BARR15_1 Belief system programmer time more important than users (Freq)		**.625**	.357	.161	.145	.401
Resistance to change	BARR8F_1 Resistance of users to innovation (Freq)	9.214 / 41.939	1.115 E-02	**.764**	.157	-5.470 E-02	2.838 E-02
	BARR21_1 Resistance due to changing the way users do their jobs instead of matching system to their work (Freq)		.103	**.751**	7.300 E-02	-8.168 E-03	.228
	BARR18_1 End users believe system not necessary to meet accreditation requirements (Freq)		.150	**.669**	-6.643 E-02	.290	-.188
Ineffective training plans	BARR19_1 Lack of training for end users in use of system (Freq)	7.432 / 49.371	.107	2.471 E-02	**.807**	-6.987 E-03	-8.703 E-02
	BARR3F_1 Users not prepared for implementation (Freq)		2.974 E-02	.264	**.665**	.234	9.883 E-02

Factor Name	Barrier	Percent of Variance / Cumulative Percent	Component 1	2	3	4	5
	BARR22_1 Higher than expected training needs for users to effectively use the system (Freq)		.272	.327	**.648**	-.197	.242
Project management	BARR1F_1 Lack of Coordination between developers and users (Freq)	6.104 / 55.474	.119	.226	.129	**.780**	-3.666 E-02
	BARR24_1 Local senior managers not clear on purpose and withhold resources (Freq)		.152	5.416 E-02	.111	**.667**	.304
Lack of local manager ownership	BARR25_1 Implementation driven by outside sponsors without local buy-in or support from local managers (Freq)	5.520 / 60.995	.212	.181	.148	.225	**.676**

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Overall Measure of Sampling Adequacy: .746

Bartlett Test of Sphericity: 779.988 Significance: .001

Summarized, the factors in this table demonstrate the respondents' perceptions of the implementation barriers related to their frequency of occurrence. The 14 barriers, clustered into five factors, are delineated. The summary statistics indicate an appropriate use of factor analysis in analyzing this attribute (Hair, et. al., 1998).

Impact of Barrier Occurrence Factor Analysis Results

The second analysis was to determine if factors for the attribute of Impact of barrier occurrence were evident. The first iteration of this analysis indicated there was one barrier (BARR13_2 - Users felt that training should be the primary means of skill development (Impact)) which did not have an adequate measure of sampling adequacy for retention (MSA: .419). This barrier was removed from the subsequent analysis resulting in a MSA of greater than .5 for all retained barriers.

Various iterations of the factor analysis for Impact, with the number of factors ranging from three to seven, were conducted to determine the factors providing the most statistically and practically significant number of factors. The result was selection of a factor analysis clustered into five rotated factors accounting for 60.227% of the variance. Scale items with values greater than .6 were selected as significant components of the resulting factors. The final rotated component matrix is as shown in Table 4.

Table 4

Rotated Component Matrix—Impact

60.227% of Variance accounted for in 5 Factors (11 Barriers)

Factor Name	Barrier	Percent of Variance / Cumulative Percent	Component 1	2	3	4	5
Control Issues	BARR16_2 Control issues - Who is in charge (Impact)	31.662 / 31.662	**.795**	-4.711 E-02	.200	8.727 E-02	-3.588 E-02
	BARR15_2 Belief system programmer time more important than users (Impact)		**.711**	.338	-8.679 E-02	7.842 E-02	.375
	BARR25_2 Implementation driven by outside sponsors without local buy-in or support from local managers (Impact)		**.654**	9.259 E-02	-4.040 E-02	.281	.113
Post-Development Issues	BARR12_2 Lack of budget for future maintenance and support (Impact)	9.189 / 40.850	.291	**.693**	.131	.196	-.131

Factor Name	Barrier	Percent of Variance / Cumulative Percent	Component 1	2	3	4	5
	BARR11_2 Inadequate testing before implementation (Impact)		.157	**.611**	.388	.207	-.280
Project Management	BARR1I_1 Lack of Coordination between developers and users (Impact)		.112	6.961 E-02	**.715**	.124	.290
	BARR6I_1 Absence of high level ownership during implementation (Impact)		.199	.124	**.660**	.247	.284
	BARR23_2 Project managers were not experienced in implementing EPSS (Impact)		.574	1.899 E-03	**.604**	- 6.423 E-02	-.180
Inadequate Implementation Plans	BARR3I_1 Users not prepared for implementation (Impact)	7.567 / 48.417	.118	.247	.359	**.713**	.114

Factor Name	Barrier	Percent of Variance / Cumulative Percent	Component 1	2	3	4	5
Resistance To Change	BARR21_2 Resistance due to changing the way users do their jobs instead of matching system to their work (Impact)	6.334 / 54.751	.235	-2.087 E-02	.243	.105	**.682**
	BARR20_2 Lack of end user belief that system will make their job easier (Impact)		1.574 E-02	.176	.143	.132	**.667**

Overall Measure of Sampling Adequacy: .759

Bartlett Test of Sphericity: 727.649 Significance: .001

Summarized, the factors in this table demonstrate the respondents' perceptions of the implementation barriers related to their impact when encountered. The five factors, comprised of 11 barriers, indicated by the analysis are delineated. The summary statistics indicate an appropriate use of factor analysis in analyzing this attribute (Hair, et. al., 1998).

Importance of Barrier Encountered Factor Analysis Results

The third analysis was to determine if factors for the attribute of Importance of barrier occurrence were evident. The first iteration of this analysis indicated there were nine barriers with an MSA less than .5. The below threshold barriers were removed from the analysis resulting in MSA of greater than .5 for all except one of the retained barriers. This barrier was removed from the third and final Factor Analysis.

Factor Analysis for the Impact attribute was examined in various iterations of three to five factors. The final selected configuration was clustered into five rotated factors with 12 barriers accounting for 62.835% of the total variance. The final rotated component matrix is as shown in Table 5.

Table 5

Rotated Component Matrix—Importance

62.835% of variance accounted for in five factors (12 Barriers)

Factor Name	Barrier	Percent of Variance / Cumulative Percent	Component 1	2	3	4	5
Lack Of End-User Buy-In	BARR20_3 Lack of end user belief that system will make their job easier (Importance)	21.528 / 21.528	**.718**	8.429 E-02	.144	7.220 E-02	-.248
	BARR18_3 End users believe system not necessary to meet accreditation requirements (Importance)		**.716**	-3.346 E-02	.324	-2.988 E-02	8.260 E-02

Factor Name	Barrier	Percent of Variance / Cumulative Percent	Component 1	2	3	4	5
	BARR10_3 Underestimating the time to implement (Importance)		**.646**	2.692 E-02	-5.408 E-02	.307	.219
Cost Consider-ations	BARR15_3 Belief system programmer time more important than users (Importance)	12.793 / 34.320	.261	**.800**	5.262 E-02	4.025 E-02	4.714 E-02
	BARR14_3 Developers thought participation by end users would extend development time (Importance)		-.142	**.701**	6.536 E-02	.338	.119
Resistance To Change	BARR8I_2 Resistance of users to innovation (Importance)	10.576 / 44.896	.280	7.338 E-02	**.790**	-7.013 E-02	1.564 E-02
	BARR3I_2 Users not prepared for implementation (Importance)		8.650 E-02	-.104	**.683**	.475	.101
Post-Develop-ment Issues	BARR19_3 Lack of training for end users in use of system (Importance)	9.197 / 54.093	.173	9.136 E-02	.171	**.755**	-.123

Factor Name	Barrier	Percent of Variance / Cumulative Percent	Component 1	2	3	4	5
	BARR12_3 Lack of budget for future maintenance and support (Importance)		5.796 E-02	.265	-.113	**.687**	.189
Project Manage-ment Issues	BARR23_3 Project managers were not experienced in implementing EPSS (Importance)	8.742 / 62.835	-.120	.234	2.417 E-02	3.112 E-02	**.674**
	BARR24_3 Local senior managers not clear on purpose and withhold resources (Importance)		.308	.285	.161	-.158	**.642**
	BARR11_3 Inadequate testing before implementation (Importance)		- 2.728 E-02	-.271	- 1.603 E-02	.332	**.634**

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Overall Measure of Sampling Adequacy: .659

Bartlett Test of Sphericity: 207.626 Significance: .001

Summarized, the factors in this table demonstrate the respondents' perceptions of the implementation barriers related to their importance in overcoming. The five factors, comprised of 12 barriers, indicated by the analysis are delineated. The summary statistics indicate an appropriate use of factor analysis in analyzing this attribute (Hair, et. al., 1998).

Factor Descriptions

The next step in the analysis was to examine the resulting barriers in each of the three factor analyses to derive a descriptive term for the resulting factors. In doing this, the higher loading factors were given higher significance in the choice of the new barrier. Table 6 shows a summary of the factors.

Table 6

Factor Names

Attribute	Factor Name	Number Of Barriers Included	Percent of Variance	Cumulative Percent of Variance
Frequency	Cost considerations	5	37.725	37.725
	Resistance to change	3	9.214	41.939
	Ineffective training plans	3	7.432	49.371
	Project management	2	6.104	55.474
	Lack of local manager ownership	1	5.520	**60.995**
Impact	Control issues	3	31.662	31.662
	Post-Development issues	2	9.189	40.850
	Project management	3	7.567	48.417

Attribute	Factor Name	Number Of Barriers Included	Percent of Variance	Cumulative Percent of Variance
	Inadequate implementation planning	1	6.334	54.751
	Resistance to change	2	5.475	**60.227**
Importance	Lack of end-user buy-in	3	21.528	21.528
	Cost considerations	2	12.793	34.320
	Resistance to change	2	10.576	44.896
	Post-development issues	2	9.197	54.093
	Project management	3	8.742	**62.835**

The 15 factors established in the analyses were then coded into new barriers. Values of the new barriers were calculated using the mean value of the original barriers contained in each of the factors. These barriers were used in later analyses to determine correlations between barriers and demographic information and corporate culture.

Corporate Culture

The next area of analysis was to analyze the responses to determine the predominant corporate culture. This portion of the survey used the methodology of Cameron and Quinn (1999) to determine the corporate culture of the respondents. In order to determine the reliability of the data obtained from the respondents, Cronbach's alpha was conducted on the responses making up each of the culture types. To accomplish this, the six values for response A were analyzed to determine the reliability of the Clan responses. Similarly, analyses were also conducted for the B, C, and D values to determine reliability of the Adhocracy, Market, and Hierarchy Culture Values. The values for alpha in this analysis are as shown in Table 7.

Table 7

Cronbach's Coefficient alpha for Culture Type

	Clan	Adhocracy	Market	Hierarchy
Alpha	.8743	.8330	.8310	.7342

All values were greater than .7, a normally accepted value for alpha (Nunnally, 1988). These values were consistent with previous uses of the Organizational Culture Assessment Inventory (Cameron & Quinn, 1999) indicating the reliability of the data and consistent validity of the instrument.

To determine the value for each of the four types of culture, the four questions in each of the six areas of this section of the survey were first recomputed into a single mean value for the responses in that area. The method for computing the value scores is shown in Table 8. For example, if a respondent provided values of 15, 25, 50, 30, 50, and 60 in the first block of each of the four blanks in the six-attribute areas of the culture survey (Appendix A, Section IV), their mean value for this component of culture would be 38.33. This value would provide the Clan culture value for this respondent.

Table 8

Computed Corporate Culture Barriers

	Clan	Adhocracy	Market	Hierarchy
	1A	1B	1C	1D
	2A	2B	2C	2D
	3A	3B	3C	3D
	4A	4B	4C	4D
	5A	5B	5C	5D
	6A	6B	6C	6D
Mean of responses above = Culture Type Value	MEAN (1A+2A+3A+4 A+5A+6A) = Clan	MEAN (1B+2B+3B+4 B+5B+6B) Adhocracy	MEAN (1C+2C+3C+4 C+5C+6C) Market	MEAN (1D+2D+3D+4 D+5D+6D) Hierarchy

Values for the respondent's perceptions of each type of culture were used to compute four new variables for each respondent corresponding to their individual value for the four culture types. These variables were then used in the in subsequent analyses. The overall values for the resulting culture types, with descriptive statistics, are as shown in Table 9.

Table 9

Descriptive Statistics for Calculated Culture

	N	Mean	Std. Deviation
Clan Culture	65	20.8179	8.77030
Adhocracy Culture	65	15.5205	5.97989
Market Culture	65	32.9077	11.93770
Hierarchy Culture	65	30.6795	9.60122

A graphic depiction of the overall culture perceived by nuclear training professionals in this study was developed by plotting the mean values shown in Table 8 using the Competing Values Framework (Cameron & Quinn, 1999). This culture is shown in Figure 4.

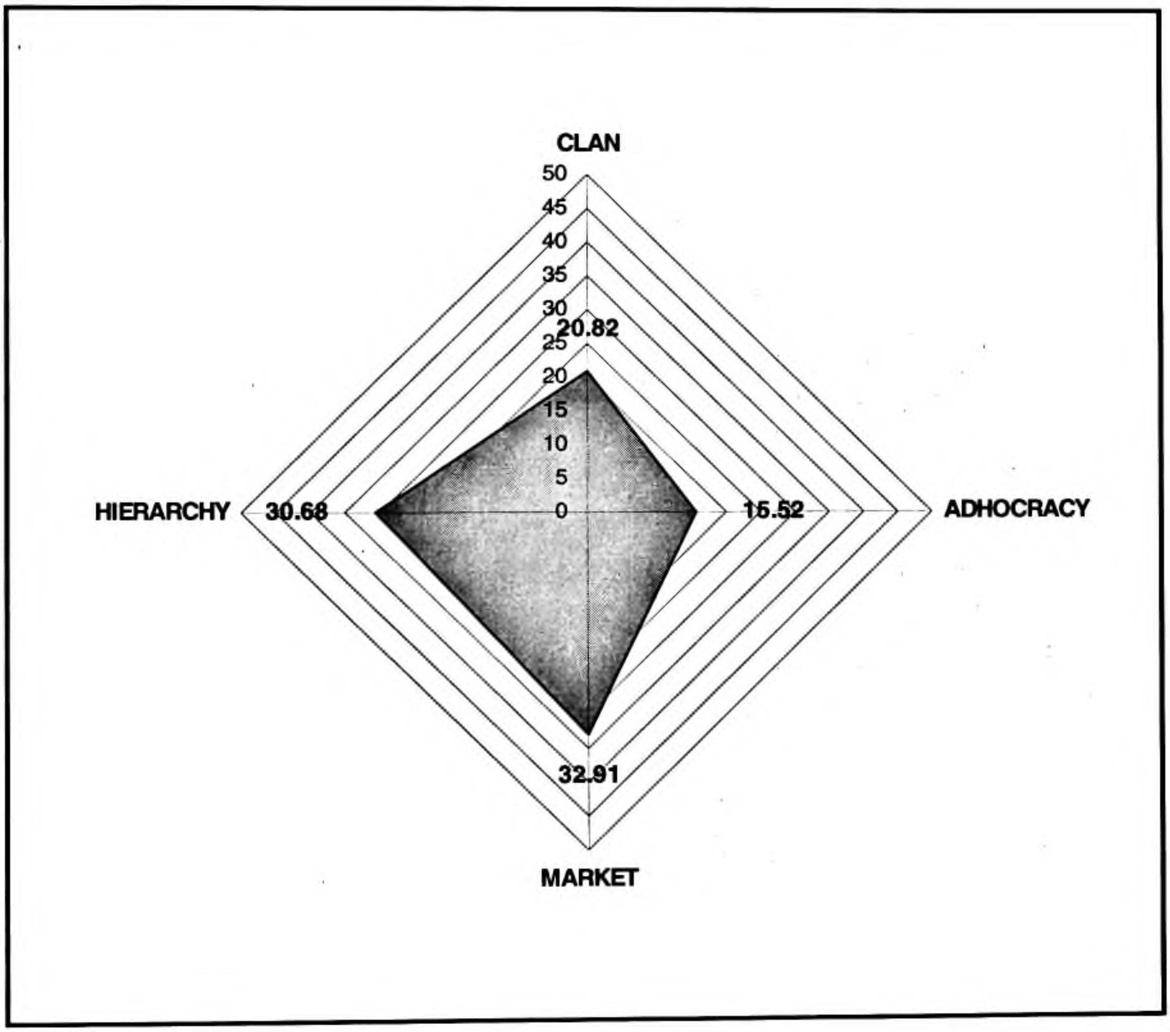

Figure 4. Corporate Culture in the Nuclear Training Industry

One-way Analysis of Variance (ANOVA) was used to determine if there were significant differences in the corporate culture based on the Role of the Responder or Single versus Multi-site utility demographics. In the case of the ANOVA for Corporate culture by Role of the Responder, the variable for Hierarchy Culture did not meet the Levene's Test for homogeneity of variance (Huck & Cormier, 1996). In this analysis, the Brown-Forsythe Test for homogeneity of variance was conducted to ensure the ANOVA met the required assumptions for homogeneity of variance. This test is generally accepted as a means of testing the assumptions for ANOVA (Huck & Cormier, 1996). The results of these ANOVA are as shown in Tables 10 and 11.

Table 10

Analyses of Variance for the Four Types of Corporate Culture and Role of the Responder

		Sum of Squares	df	Mean Square	F	Sig.
CLAN - Clan Culture	Between Groups	435.552	6	72.592	.938	.475
	Within Groups	4487.211	58	77.366		
	Total	4922.762	64			
ADHOCRAC - Adhocracy Culture	Between Groups	283.134	6	47.189	1.365	.244
	Within Groups	2005.450	58	34.577		
	Total	2288.584	64			
MARKET - Market Culture	Between Groups	203.089	6	33.848	.220	.969
	Within Groups	8917.469	58	153.749		
	Total	9120.557	64			
HIERARCH - Hierarchy Culture	Between Groups	1048.924	6	174.821	2.090	.068
	Within Groups	4850.816	58	83.635		
	Total	5899.739	64			

Table 11

Analyses of Variance for the Four Types of Corporate Culture and Single or Multi-Site Utility

		Sum of Squares	df	Mean Square	F	Sig.
CLAN - Clan Culture	Between Groups	85.645	1	85.645	1.115	.295
	Within Groups	4837.117	63	76.780		
	Total	4922.762	64			
ADHOCRAC - Adhocracy Culture	Between Groups	7.242	1	7.242	.200	.656
	Within Groups	2281.342	63	36.212		
	Total	2288.584	64			
MARKET - Market Culture	Between Groups	409.254	1	409.254	2.960	.090
	Within Groups	8711.304	63	138.275		
	Total	9120.557	64			
HIERARCH - Hierarchy Culture	Between Groups	63.300	1	63.300	.683	.412
	Within Groups	5836.439	63	92.642		
	Total	5899.739	64			

In both cases, analysis of the results of the respective ANOVA indicates there is no statistically significant difference in the perceived corporate culture based on whether the respondent is part of a single or multi-site utility. This is also the indicated result of the effect of the positions of the respondent in the organization. Both ANOVA were analyzed using SPSS at the $\rho < .05$ significance level utilizing the Bonferroni Correction Factor built into the SPSS procedure.

Correlations between Barrier Factors, Demographic Information, Overall Satisfaction, and Corporate Culture

A Pearson Product-Moment correlation matrix was used to analyze correlations among the factors determined for Barriers to Effective Implementation, demographic information provided by the respondents, overall satisfaction with the Electronic Performance Support System, and Corporate Culture. A Bonferroni correction factor was used to adjust for the multiple analyses conducted with the data set. Forty-one statistically significant ($\rho < .05$ with Bonferroni Correction Factor to .001389) correlations were indicated in the resulting 36 by 36 correlation matrix. A summary of the statistically significant correlations are shown in Tables 12 through 17. Actual values for the correlations are as seen in Appendix C, Table C6.

Table 12

Statistically Significant Correlations—Frequency Factors

	F1FREQ Cost Considerations	F2FREQ Resistance to Change	F3FREQ Ineffective Training Plans	F4FREQ Project Management	F5FREQ Lack of Local Manager Ownership
F3FREQ Ineffective Training Plans	X				
F4FREQ Project Management	X				
F5FREQ Lack of Local Manager Ownership	X				
F1IMPACT Control Issues	X			X	X
F2IMPACT Post-Development Issues	X				
F3IMPACT Project Management	X			X	
F4IMPACT Inadequate Implementation Planning			X	X	
F5IMPACT Resistance to Change		X	X		X

	F1FREQ Cost Considerations	F2FREQ Resistance to Change	F3FREQ Ineffective Training Plans	F4FREQ Project Management	F5FREQ Lack of Local Manager Ownership
SATISFIE Satisfied with the performance of system implemented	X			X	
DID NOT System did not provide gains in efficiency expected	X				

Cost considerations was the most frequently indicated correlation (n = 8). Project management issues was the next most indicated correlation (n = 4). Additionally, lack of local manager ownership and ineffective training plans were each indicated twice. Finally, resistance to change was indicated in one correlation.

Table 13

Statistically Significant Correlations—Impact Factors

	F1IMPACT Control Issues	F2IMPACT Post-Development Issues	F3IMPACT Project Management	F4IMPACT Inadequate Implementation Planning	F5IMPACT Resistance to Change
F3IMPACT Project Management	X				
F4IMPACT Inadequate Implementation Planning			X		
F5IMPACT Resistance to Change			X		
F3IMPORT Resistance to Change				X	
F4IMPORT Post-Development Issues		X			
F5IMPORT Project Management			X		

The factors most often correlated to Impact on the implementation of the Electronic Performance Support System were related to project management (n = 4). An additional single correlation was indicated in Control Issues, Post-development issues, and inadequate implementation planning. Resistance to change impact was not indicated as having any significant correlations to other variables.

Table 14

Statistically Significant Correlations—Importance Factors

	F1IMPORT Lack of End-User Buy-in	F2IMPORT Cost considerations	F3IMPORT Resistance to Change	F4IMPORT Post-Development Issues	F5IMPORT Project Management
F1FREQ Cost Considerations		X			
F3FREQ Ineffective Training Plans				X	
F1IMPACT Control Issues		X			
F2IMPACT Post-Development Issues		X			

Cost considerations was most often correlated with another factor (n = 3), while post-development issues was indicated in one correlations. Lack of end-use buy-in, resistance to change, and project management were not indicated in any significant correlations.

Table 15

Statistically Significant Correlations—Culture Types

	CLAN Clan Culture	ADHOCRAC Adhocracy Culture
MARKET Market Culture	X	
HIERARCH Hierarchy Culture		X

There was a statistically significant correlation between the Clan and Market Culture in the responses to this survey. An additional relationship was indicated between the Hierarchical and Adhocracy Cultures. These correlations were both negatively correlated (-0.71541 and -0.51313). Negative correlations in these attributes are consistent with the opposing nature of the culture types they are based upon in the Competing Values Model.

Table 16

Statistically Significant Correlations—Overall Satisfaction with Electronic Performance Support System

	SATISFIE Satisfied with the performance of system implemented	WORTHEFF System was worth effort expended	DID NOT System did not provide gains in efficiency expected
WORTHEFF System was worth effort expended	X		
DID NOT System did not provide gains in efficiency expected	X	X	
INSTBELI Instructors using system believe it has made their job easier	X	X	X
COST Estimated cost of implementation			X

The correlations in this analysis indicate an overall dissatisfaction with the performance of the Electronic Performance Support System and the system's capability to provide the gains in efficiency expected.

Table 17

Statistically Significant Correlations—Demographic and Electronic Performance Support System Development Description

	MULTISIT Part of Multi-Site Utility	INHOUSE EPSS Developed In-house	THIRD_P Developed by 3rd Party	NETWORKE Networked EPSS for multiple sites
NETWORKE Networked EPSS for multiple sites	X	X	X	
COST Estimated cost of implementation				X

In addition to the correlation matrix, Crosstabs were constructed to investigate possible relationships between the variables. With application of the Bonferroni adjustment factor, none of the 109 individual Crosstabs indicated statistical significance ($\rho < .05$, with Bonferroni Correction Factor to .00046).

Overall Satisfaction with the Electronic Performance Support System

To determine the overall satisfaction with the Electronic Performance Support System implemented at the respondents' station, a One-Way ANOVA was performed with a Bonferroni correction factor applied in the SPSS process. The variables analyzed were: (1) System was worth the effort expended, (2) Satisfied with the performance of system implemented, (3) Would implement another EPSS in our department, (4) System did not provide gains in efficiency expected, and, (5) Instructors using system believe it has made their job easier. Only one of the relationships was statistically significant—DID NOT—System did not provide gains in efficiency expected, with values as shown in Table 18. The ANOVA for the remaining variables are provided in Appendix C, Table C7.

Table 18

ANOVA of Overall Satisfaction with Electronic Performance Support System

		Sum of Squares	df	Mean Square	F	Sig.
DIDNOT System did not provide gains in efficiency expected	Between Groups	3.912	1	3.912	4.309	.042
	Within Groups	54.475	60	.908		
	Total	58.387	61			

Additional Response Data

In addition to providing responses to the specific barriers identified in the review of literature conducted for this study, the respondents were requested to identify and rate any additional barriers they had experienced during the implementation of Electronic Performance Support Systems. Three respondents provided seven additional barriers. These barriers are provided in Appendix C, Table C2. These barriers are similar to the factors making up Post-development Issues, Cost Considerations, and Project

Management and were not entered into the previous analyses due to their single entry nature.

Comparison of Findings

Previous research indicated a number of barriers had been encountered by professionals during the implementation of Electronic Performance Support Systems. Anecdotal information reported these barriers were evidenced to varying degrees in a number of industries (Benson, 1997; Hall, 1996; Kemske, 1997; and Rosett, 1996). Paralleling these results, the respondents to this study indicated these barriers were also evident in the implementation of Electronic Performance Support Systems in the nuclear training industry. There were no indications that the barriers were perceived as more or less evident when analyzing responses for either single or multi-site utilities or the role of the responder in the organization.

Consistent with previous research on organizational change (Atchison, 2002; Kotter, 1996; Kotter and Heskett, 1992), the factors derived from the barriers presented in this study were similar to those in other change efforts. Similarities included (factors in this study in parentheses) costs more than expected (cost considerations), acquisitions do not provide synergies expected (Lack of Expected Increases in Efficiency), lack of a guiding coalition (Lack of Local Manager ownership), and declaring early victory (Post-Development Issues and Inadequate Implementation Planning). Additional factors in this study related to resistance to change and control issues are similar to the errors in change management Kotter (1996) described as failing to anchor change in the corporate culture.

The respondents' indications of the corporate cultures in the training departments represented in this study were consistent with previous studies conducted in the nuclear industry (Hooijberg & Petrock, 1993; Petrock, 2002). Additionally, analyses of the responses indicated consistent reliability and validity compared to studies previously conducted or referenced by the authors of the Organizational Culture Assessment Instrument (Cameron and Quinn, 1999). This indicates the culture indicated in this study appropriately describes the culture of the responding utilities. The culture was consistent for both multi-site and single-site utilities indicating the relative size of the organization was not a significant factor in this study. The number of respondents to this study precluded analysis of variance in the culture by other demographic factors such as the role of the respondent.

Summary

Previous studies of organizational culture and corporate change efforts have indicated factors that transcend the type of organization (Kotter, 1996: Kotter and Heskett, 1992; Schein, 1984). Many of problems identified in change management in these studies were similar to the factors determined in this study. The prevailing corporate culture of the organization is often a factor in the overall resistance or susceptibility of an organization to change (Schein, 1984, 1996, 1999). The characteristics of the Hierarchy and Market cultures are consistent with the factors of barriers related to Resistance to Change, Cost Considerations, Control Issues, Focus on System Performance, and Lack of local Ownership. As is the often the case in ineffective change efforts, the response that the respondents did not perceive their organization had experienced the gains in efficiency expected as a result of the Electronic Performance Support System implemented is not unexpected.

Chapter 5

SUMMATION, CONCLUSIONS, AND RECOMMENDATIONS

This chapter provides a summary of this research to readers. Additionally, the conclusions formulated from this study are delineated along with recommendations for further research. The final section of this study will reiterate the limitations of the study as a caution to readers as to the generalizability of the findings.

Summation

The purpose of this study was to describe relationships between commonly encountered barriers to the effective implementation of Electronic Performance Support Systems and organizational culture in the nuclear training industry. Providing a contribution to the body of knowledge related to the effect of commonly encountered barriers to effective implementation of Electronic Performance Support Systems was the impetus for conducting this study. To date, the primary source of information related to barriers to implementation of Electronic Performance Support Systems, and their relative impact on effectiveness, was in the form of qualitative reports on individual and collective projects.

Two research questions guided this study. In the first research question, the focus was on determining the relationships between training professional's perceptions of individual barriers to implementing Electronic Performance Support Systems and corporate culture. Emphasis in the second research question was on determining training professionals' perceptions of the relationships among individual barriers to implementing Electronic Performance Support Systems.

Conduct of the Study

Participants for this study were solicited from the population of nuclear training departments of licensed nuclear utilities in the United States. All nuclear power plants and corporate training organizations were invited to participate in the study (N = 70). Two-hundred and eighty instruments were distributed and 65 usable surveys were returned for analysis.

A review of literature related to barriers to effective implementation of Electronic Performance Support Systems and common demographic factors representing the nuclear training industry guided development of the survey. The culture instrument used was the Organizational Culture Assessment Instrument developed by Cameron and Quinn (1999). Responses were recorded and analyzed using SPSS (2001) statistical software.

Analysis of Survey Results

Survey Reliability

Initial analysis focused upon the internal consistency of the instrument. Because the instrument employed seven distinct question formats (Frequency, Impact, Importance, and the Four Culture Types), coefficient alphas were computed separately for each element. Coefficient alphas of .9151 (Frequency), .9101 (Impact), and .7739 (Importance) were computed related to the responses regarding barriers. The results were interpreted that the scales possessed acceptable reliability for research purposes (Nunnally, 1988).

While all three barrier attributes data indicated satisfactory reliability (α >.70), the individual item reliabilities in the Importance Attribute indicated the lowest reliability. Further investigation indicated three variables had significant disagreement in the values provided by the respondents. All three questions were related to end user perceptions of the values of the system being implemented or need for the system. The three variables were lack of awareness of need for system by end users, lack of end user belief the system will make their job easier, and resistance due to changing the way users do their jobs instead of matching system to their work. Additional review of the patterns of responses indicated no discernable pattern in the differences in responses related to type of utility or role of the responder as a cause for the lower reliability of these responses.

Coefficient alphas for the four culture factors—Clan, Adhocracy, Market and Hierarchy—were .8743, .8330, .8310, and .7342 respectively. These values for alpha were comparable to previous reports on the reliability of the Organizational Culture Assessment Instrument provide by Cameron and Quinn (1999). The assessment that both portions of the instrument were within acceptable research norms provides an indication that future analyses using this instrument should also provide satisfactory results for interpretation.

Factor Analysis

The factor structure of the instrument responses was examined using principal component factor analyses followed by Varimax rotations. Separate analyses were performed for each of the barrier attributes of Frequency, Impact, and Importance. Using the criteria for minimum factor loadings established from the review of literature and established in the research methodology, the results of the factor analyses were interpreted to determine the factor structure. The resultant clustering of barriers indicated there were five distinct factors identifiable for each of the three attributes.

Frequency attribute of barriers.

Frequency of a specific barrier occurring during the implementation of an Electronic Performance Support System was the first attribute respondents were requested to rate. Each of the barriers was rated on a one to five scale based on the perceptions of the respondent. For the attribute of Frequency, approximately 61% of the variance was accounted for in five factors.

The first factor was made up of five barriers including extended development time, unexpected cost increases, lack of budget for future maintenance and support, focus on system performance rather than user performance, and a belief that system programmer time was more important than users. Barriers comprising this factor are related to cost considerations during development and implementation of the system. This factor is labeled Cost Considerations.

The second factor consists of three barriers: resistance of users to innovation, resistance to changing the way users do their jobs rather than matching the system to the users work, and end users beliefs that the system is not necessary to meet accreditation (job) requirements. Summarized, these factors describe various forms of resistance to change on the part of the users. Resistance to Change is the descriptive term for this factor.

Ineffective Training Plans is the label for the third factor for the attribute of Frequency. The component barriers were: lack of training for end users in the use of the system, users not prepared for implementation, and higher than expected training needs for users to be effective. These factors are summarized as describing ineffective planning for the training needed to support the users of the system.

Factor four related to Frequency, was attributed to problems with project management. Two barriers were included in the factor: lack of coordination between developers and users, and local managers not clear on the purpose of the system and withhold resources. This factor is labeled Project Management.

The last factor is labeled Lack of Local Manager Ownership. This factor consisted of one barrier. This barrier describes implementation driven by outside sponsors without local buy-in or support from local managers.

Impact attribute of barriers.

Impact was the second barrier attribute for which factors were determined. Respondents rated each barrier for the overall impact that had been experienced during the implementation of an Electronic Performance Support System. In this factor, approximately 60% of the variance was accounted for in five factors. The first factor for this attribute is labeled Control Issues and is made up of three barriers. These barriers are: Control issues—who is in charge, belief system programmer time was more important than users, and implementation driven by outside sponsors without local buy-in or support from local managers.

The second factor is Post-development Issues. This factor is composed of two barriers delineating lack of budget for future maintenance and support and inadequate testing before implementation. Both of these barriers described problems arising after the initial development and implementation of the system.

Three barriers comprise the third factor. This factor is labeled Inadequate Project Management. Barriers in this factor include lack of coordination between developers and users, absence of high-level ownership during implementation, and project managers were not experienced in implementing Electronic Performance Support Systems.

The fourth attribute is made up of one barrier. This barrier is users not prepared for implementation. Factor four is labeled Inadequate Training Plans.

Resistance to Change is the label given the fifth factor for the Impact attribute. This factor is made up of two barriers: resistance to changing the way users do their jobs instead of matching the system to their work and lack of end user belief that the system will make their job easier. The remaining 13 barriers were not specifically related to individual factors.

Importance attribute of barriers.

The third barrier attribute analyzed for factors was Importance. The respondents rated each barrier for their overall impression of the importance of this barrier related to the implementation of an Electronic Performance Support System. This factor structure clusters into five factors, accounting for 63% of the variance in 12 barriers. Lack of End-User Buy-in is the first factor. Comprised of three barriers, this factor included: lack of end user belief that the system will make their jobs easier, end users believe the system is not necessary to meet accreditation requirements, and underestimating the time to implement the system.

Second in this factor structure is Cost Considerations. Made up of two barriers, this factor appears related to time increases in system development and concurrent cost increases. The barriers were belief system programmer time was more important than users', and developers thought participation by end users would extend development time.

Two barriers make up the third factor for this attribute. This factor was labeled Resistance to Change. The two barriers were resistance of users to innovation, and users not prepared for implementation.

Labeled Post-Development issues, the fourth factor of this attribute has two barriers loading adequately for inclusion. These barrier described issues that arise after the development and implementation of the Electronic Performance Support System. Barriers in this factor included lack of training for end users in the use of the system, and, lack of budget for future maintenance and support of the system.

The fifth set of barriers achieving adequate factor loading to be considered in this factor structure were—project managers were not experienced in implementing an Electronic Performance Support System, local senior mangers not clear on the purpose of the system and withhold resources, and inadequate testing before implementation. These barriers are generally related to issues that should have been resolved by project managers. This factor is labeled Project Management Issues.

Factor Analysis Summary

Overall, the results of the factor analysis met statistical criteria to be acceptable for research purposes within the limitations of the study being performed. Additionally, the factors determined from the analyses appear to have content validity. The factors derived in this data were compared to the literature on organizational culture. Two factors—resistance to change and project management—were indicated in all three dimensions of Frequency, Impact, and Importance. Cost considerations were indicated in two of the three attributes. These issues are also reported in previous research on organizational change (Kotter, 1996; Kotter & Heskett, 1992; Rummler & Brache, 1995). Rummler and Brach (1995) also reported that issues related to lack of senior management ownership, focusing on development without proper implementation plans and failure to anticipate implementation problems are potential barriers to process improvement. Hair, et. al. (1998) caution that the results of a single factor analysis, due to the limitation of single data-sets, sampling error, and other potential error precursors may produce a plausible solution which may not subsequently prove to be either reliable or valid. The similarity of the factors identified in this study to those identified in previous studies provides a more positive consideration of the content validity of the factor structure.

Nuclear Training Organization Culture

Predominant Corporate Culture

Analysis of culture of the respondents' nuclear training departments indicated predominant ratings in the Market and Hierarchy quadrants with mean values of 32.91 and 30.68 respectively. Lower ratings were indicated in the Clan (mean = 20.82) and

Adhocracy (mean = 15.62) culture quadrants. These values were consistent with the previous studies of the nuclear industry by Denison (2001) and Petrock (2002). In Denison (2001), a study of a nuclear utility indicated a change from an internally focused organization to a more externally focused organization during the 1970s. Changes in the organization were attributed to a combination of factors including increased regulation and political intervention in the nuclear industry after the Three Mile Island accident in 1978, and cultural changes to accommodate increased diversity in the workforce.

Similar changes are taking place today as the nuclear industry shifts from a public regulated utility to a market driven orientation during deregulation efforts in most states. Petrock (1993), in a study of the Davis-Besse Nuclear Power Plant found men values of approximately 45 and 35 in the Market and Hierarchy quadrants and mean values of 10 and 10 in the Adhocracy and Clan cultures. These results indicate the nuclear culture in the training departments of the respondents to this survey are becoming more receptive to the needs of individuals (Clan), increased adaptation and resource acquisition (Adhocracy), while maintaining a propensity toward a Hierarchical Culture with a strong Market orientation. As the nuclear industry has undergone a significant period of mergers and acquisitions in the last several years, these changes should be expected. However, the amount of organizational change going on because of these corporate sponsorship changes may be contributing to additional resistance to change efforts.

The nuclear industry is highly regulated from an operational standpoint. Risks to the public from a nuclear accident, however unlikely to occur, are significant and warrant a high degree of regulation and oversight. This is evidenced by the regulatory perspective of the Nuclear Regulatory Commission and industry-sponsored self-regulation from the Institute of Nuclear Power Operations and the National Academy of Nuclear Training. Regulation and oversight of this nature are consistent with the attributes of a hierarchical culture including stability, documentation, and control.

In addition to the effects of a corporate culture influenced by significant external regulation, the nuclear industry has recently undergone a transformation from a regulated public utility to a market driven, stockholder value-added, business model. This has led to increased emphasis on profit margins and effectiveness—attributes of the Market Culture. The competing values of market competitiveness, coupled with continued regulation from a safety standpoint, generate a continuing challenge to the persons leading and working within the nuclear industry.

Alignment between Respondents

ANOVA was conducted on the respondents' ratings of the corporate culture to determine if there were significant differences in the responses based on the respondent's position in the organization and if the organization was part of a multi-site utility. There were no significant differences ($\rho < .05$) in the mean values of the corporate culture based on these demographic factors. This lack of differentiation between large and smaller organizations and between management and individual contributors in the nuclear training organization indicate alignment in objectives and values.

The presence of this alignment indicates that the responses are consistent and representative of the general training culture. A primary rationale for this alignment may be that almost all members of the training organization have worked for years within the nuclear industry. In one typical training department, the average age of the workers is approximately 47. Many of the instructors and managers have over 20 years of experience within the nuclear industry. Corporate cultures are typically established over years of existence and workers are indoctrinated to the corporate culture over their years of experience (Cameron and Quinn, 1999; Schein, 1984, 1996). Raising managers from the ranks of the people they subsequently supervise may tend to maintain similarity in the perceived culture in the respondent groups.

In addition to the internal culture of the individual organizations, the nuclear industry places high emphasis on consistency between utilities. It is very common for industry leaders to move from utility to utility during their careers. This tends to provide a common basis for values and decision making in various organizations.

Nuclear training program accreditation processes also require the use of peers from other utilities when completing assessments. This provides a basis for sharing and benchmarking of best practices. When the effects of these exchanges are coupled with a significant emphasis on sharing knowledge of weaknesses identified during external and internal assessment conducted in the industry, it is should not be unexpected when the corporate cultures indicated in utilities of differing sizes do not vary significantly.

Correlation between Culture and Barriers

Factors determined from the respondents' rating of barriers were analyzed for their relationship to each other and to corporate culture in a component matrix using Pearson Product-Moment. Including a Bonferroni Correction Factor, there were 32 statistically significant correlations ($\rho < .05$ with Bonferroni Correction Factor). None of these correlations was between factors determined from barriers and corporate culture.

In addition to the relationships between corporate culture and barrier factors, correlations were also determined between barrier factors, demographic information, and overall satisfaction of the respondents with the Electronic Performance Support System with which they were experienced. There were 11 statistically significant correlations between these barriers. None of these demographic or satisfaction-related barriers was correlated with a specific type of corporate culture. One possible explanation for this result is that the corporate culture evidenced in the nuclear training industry is a construct with varying degrees of all four culture types concurrently evident. The resulting interaction of culture types may have precluded participants' responses from being significantly correlated with specific factors related to barriers in this study.

One-way ANOVA was used to determine if there were statistically significant differences in the respondent's responses related to the respondent's overall satisfaction with the Electronic Performance Support System with which they were experienced. Statistically significant relationships in one of the ANOVAs was indicated (Sig. .042, $\rho < .05$). Analysis of the data indicated the respondents did not perceive the system had provided the gains in efficiency expected.

Conclusions

When discussing reasons for the failure of organizational change efforts, Cameron and Quinn stated ". . . the most frequently cited reason for failure was a neglect of the organization's culture" (1999, p. 1). Comparing the responses in this study to the

Competing Values Framework (Quinn, 1988) indicates the organizational culture of the nuclear training industry is predominantly focused on predictability and order. Both the Market and Hierarchy cultures evidenced in the respondents' descriptions of their cultures shows the respondents' perceptions of the value placed on such qualities as stability, control, direction, and decisiveness. Members of these cultures do not place the emphasis on flexibility and spontaneity present in the Clan or Adhocracy cultures. This focus is consistent with resistance to change (Cameron and Quinn, 1999; Denison, 2001; Petrock, 2002; Schein, 1984, 1996).

An emphasis on productivity coupled with stability provides insight into the respondents' perceptions that the Electronic Performance Support Systems implemented had not provided the gains in efficiency expected. Respondents whose entire careers have placed a high value on compliance with regulatory standards, information management, and error-free performance may have a low tolerance with the potential issues that may arise during a complex change in the way they conduct business. Coupling this low tolerance for error with an increasing emphasis on meeting business goals (driven by the increasing emphasis on productivity and profitability driven by a transition to a market oriented business environment), it is possible the nuclear professional's low tolerance for error is emphasized and manifested in their perceptions toward change projects.

Based on the analyses in this study, the following conclusions were formulated related to the relationship between corporate culture and implementation of Electronic Performance Support Systems. The results of this study indicated no significant relationships between organizational culture and the factors related to barriers to effective implementation of Electronic Performance Support Systems within the nuclear training industry. Lack of relationships between organizational culture and specific barriers examined in this study indicates characteristics of ineffective change management may not be specific to the organizational culture where change is occurring.

This provides a valuable potential insight to Electronic Performance Support System implementation project managers. By using proven change management and organizational development practices, managers of future Electronic Performance Support System implementation projects may avoid those issues common to large-scale change management such as resistance to change, cost considerations, and project management. As was seen in the results of this study (Table 6), these factors were the most prevalent in relating Frequency, Impact, and Importance when implementing Electronic Performance Support System projects.

The factor structure for barriers related to training professional perceptions of the barriers to effective implementation of Electronic Performance Support Systems indicates there are relationships among individual barriers. Factor structures determined in this study are consistent with characteristics of resistance to change identified in other studies of organizational change (Cameron and Quinn, 1999; Denison, 2001; Kotter, 1996). Project managers recognizing that resistance to change is a significant barrier to effective implementation of Electronic Performance Support Systems can take measures to counter this resistance.

The first research question in this study was—What are the relationships between organizational culture and training professionals' perceptions of barriers to implementing Electronic Performance Support Systems? The null hypothesis related to this question was—the research will indicate no statistically significant relationship between organizational culture and barriers encountered when implementing Electronic Performance Support Systems. Based on the lack of significant relationships between culture in the nuclear training industry and factors determined from implementation barriers, the null hypothesis cannot be rejected.

In regards to the first research question, while the existence of barriers related to specific culture types was not established, the content validity and indicated reliability of the data provide information with practical significance to managers. The results of this study provides project managers additional information on potential barriers to effective implementation of an Electronic Performance Support System they may factor into implementation plans designed to avoid the effects of these barriers.

The second research question in this study was—What are the relationships among training professionals' perceptions of individual barriers to implementing Electronic Performance Support Systems? The null hypothesis for this question was—the research will indicate no statistically significant relationships among training professionals' perceptions of individual barriers to implementing Electronic Performance Support Systems. Based on the internal consistency of the responses and the factor structure derived from the data, the null hypothesis for the second research question in this study is rejected. The content validity of the factor structure derived in this study is also supported by the similarity to other researcher's findings related to organizational change.

Practical Implications for Managers

The findings of this study indicate barriers commonly encountered during the implementation of an Electronic Performance Support Systems are similar to those encountered in many large-scale organizational change projects. For instance, resistance to change was established as a factor for all three of the attributes rated for the barriers—Frequency, Impact, and Importance. This indicates managers should be proactive at addressing possible resistance during the planning and implementation phases of an Electronic Performance Support System project.

Another factor encountered in all three attributes was project management. This indicates project managers may be a key to effective implementation of an Electronic Performance Support System. For instance, their experience in planning for implementation problems and dealing with end-user resistance to change could improve the success rate in effectively implementing an Electronic Performance Support System. While not directly examined in this study, the experience and/or training of project managers related to dealing with barriers could affect the success of the project.

Cost considerations were also a common factor in the Frequency and Importance attributes of the barriers assessed in this study. Since Electronic Performance Support Systems are primarily implemented to improve effectiveness of the workers who will be using them, and the costs are often quite consequential, it is incumbent on managers to avoid any barriers that could affect the overall cost of the implementation.

While there were no statistically significant relationships between the factors established in this study and the corporate culture of the nuclear training industry, the overall factor structure provides similar content to the characteristics of the culture model of Schein (1984, 1996) and the Competing Values Model of Cameron and Quinn (1999). This indicates a general knowledge of corporate culture and the Competing Values Model may be of benefit to managers. Corporate change requires people to change "the way we do things here," and resistance to this change may be encountered in many forms.

Recommendations for Further Research

Based on the findings and conclusions of this work, recommendations for additional research are presented to address the following issues. First, an expanded random sample of users of Electronic Performance Support Systems is needed to substantiate the results of this study. Repeated administration and evaluation of the instrument developed during this study will increase the validity of the instrument, provide additional credibility to the factor structure derived in this study, and provide support for the conclusions presented in this study. Additionally, the administration of the instruments used in this study with a larger population would allow the use of Confirmatory Factor Analysis to improve the power of the study (Hair, et. al., 1998).

Second, as stated previously, the purpose of this study was to determine if there were relationships between corporate culture and factors related to barriers to effective implementation of Electronic Performance Support Systems. Since the corporate culture derived from the perceptions of the respondents to this study was relatively homogeneous in nature, additional relationships between these attributes may become evident if the respondents of future studies are from varied corporate cultures. Additional studies could be conducted with purposive samplings of organizations with cultures that are known to exhibit traits dissimilar to those of the nuclear training industry.

Third, a study of organizations employing change management techniques targeted at countering the barriers identified in this study could be completed. Such studies would meet the goal of this study to improve the efficiency of organizations in successfully implementing Electronic Performance Support Systems as a means of performance improvement. Information gained from additional studies of this design could provide quantitative substantiation of the value of being familiar with potential problems when developing and implementing plans for organizational change.

Fourth, pre- and post-effort studies could be conducted comparing previous Electronic Performance Support System implementation projects within an organization and current or future Electronic Performance Support System implementation projects. Project managers could use the conclusions of this study to design interventions to mitigate the effects of barriers identified in this study. Quantitative or qualitative analysis of such efforts could provide confirmation the barriers in this study are manageable with adequate prior knowledge and planning.

Last, comparative studies of Electronic Performance Support System implementation in corporate processes other than training applications would determine if the factor structure established in this study continues to exhibit similarity to those exhibited in other organizational change issues. Such studies could determine if there were factors in organizational change that vary between types of organizational change efforts. For instance, such a study might compare the barriers to implementation encountered in an organizational change project dealing with implementation of an Electronic Performance Support System used for financial management or stock control to projects involving the implementation of Electronic Performance Support System for training support.

Limitations of the Study

Readers should be cautioned regarding the limitations of this study. First, the extent to which findings of this study are generalizable is unknown. Because this study was conducted using a population within a single industry, the results may not be directly generalized to other training organizations or industries. Additionally, the relatively small size of the sample responding to this study may provide limited generalizability to the overall nuclear training industry. The number of non-responders may indicate the sample in this study may not be representative of the overall perceptions of the rest of the nuclear training industry.

As is common with most survey research using a convenience, or non-random sample, for analysis may induce a degree of bias into the results that would not occur with a truly random sample of the population. While the demographics of the respondents in this study are representative of the overall makeup of the industry, there was insufficient data to determine if demographic factors other than the position of the respondent or the size for the organization would provide significantly different results.

The second limitation centers on the relative homogeneity of the culture of the respondents to this study. This homogeneity may have contributed to Type-2 error in the analyses of the study. There may be relationships between specific barriers and specific corporate culture types that were not detected in this study. The lack of identified relationships between culture and barriers to Electronic Performance Support System implementation may discourage a manager from targeting interventions where a culture type different from that of the nuclear training industry is known to exist.

A manager's prior knowledge of potential barriers to effective implementation of organizational change management projects may be a significant factor in project success. Considering the increasing use of Electronic Performance Support Systems to improve worker performance in many industries, the addition to the body of knowledge regarding barriers to effective implementation of an Electronic Performance Support System is increasingly valuable. This study provides quantitative insight into potential barriers to the effective implementation of Electronic Performance Support Systems. Improved knowledge of the barriers to effective implementation of Electronic Performance Support Systems should assist managers of future projects of this nature. Taking into account that 41 of 65 respondents to this study indicated they would implement another Electronic Performance Support System in their department, knowledge leading to the effective implementation of these systems becomes a business imperative.

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APPENDICES

Appendix A: Survey Instrument

Training Professionals' Perceptions: A Study between Corporate Culture and Barriers to Implementing Electronic Performance Support Systems in Nuclear Industry Training

Thank you for taking the time to complete this survey. Your completion of this survey will be accepted as your consent to participate in this research project. Should you decline to participate or decide not to complete the survey you are free to do so without penalty. Any questions about this survey may be directed to the VSU IRB Administrator, Dr. Mary H. Watson at 229-333-7837. Thank you again for your assistance.

Richard E. Cole, 8686 Yellowstone Drive, Byron, IL 61010, 815-234-4646

You are participating in a study of barriers to effective implementation of Electronic Performance Support Systems to manage training programs in the nuclear industry. Responses will be used to determine what barriers have the most impact on effectively implementing this type of system. For the purposes of this study, an Electronic Performance Support System is defined as:

> *A computer application providing software-based performance support to instructional systems development and the management of training programs. In other words, this would be any computer-based repository of task, learning objective, evaluation item, or training materials used to support an accredited training program. It is not necessary for the system to contain all of these components. These systems may be either commercially procured or self-developed by a utility or individual training department.*

Individual responses will remain confidential and the results of the study will be shared with the nuclear industry.

Directions:

1. **Each person participating in the survey will complete one of the enclosed forms. They may be completed using pencil or ink. Responses should be provided directly on the included instrument.**
2. **Each respondent is requested to complete the survey independently based on their best estimate of the proper response to the question.**
3. **No identification of either stations or individual respondents is desired in this survey. All responses will be maintained in confidence by the researcher and results published only as an aggregate using the demographic information requested in the survey.**
4. **Completed surveys should be returned in the enclosed self-addressed envelope within 30 days of receipt at your station.**

Section I

General Information –	Answer

Select all that apply	
What was your role in the implementation of the system? (Choose One)	
Site Training Department Manager or Director	☐
Training Department Supervisor or Unit Manager (Operations, Maintenance and Technical, etc.)	☐
Electronic Performance Support System Developer	☐
Database Administrator in the Training Department	☐
Training Program Lead Instructor	☐
Instructional Technologist	☐
Training Program Instructor	☐
Is your station part of a multi-site utility (TVA, Exelon, etc)?	☐Yes ☐No
Your organization is the corporate office of a single or multi-site utility.	☐Yes ☐No
Was your program developed using in-house expertise to meet your specifications?	☐Yes ☐No
Was your program developed by a contractor specifically to meet your specifications?	☐Yes ☐No
Was your program purchased from a third party developer and used without modifications?	☐Yes ☐No
Did you replace a self-developed database with a commercial training management Electronic Performance Support System?	☐Yes ☐No
Is your Electronic Performance Support System being networked to support training programs at multiple stations?	☐Yes ☐No
Is your Electronic Performance Support System implementation project complete?	☐Yes ☐No
Did you abandon an Electronic Performance Support System project because of implementation problems?	☐Yes ☐No
Did you use outside consulting resources to manage the implementation of your Electronic Performance Support System?	☐Yes ☐No
What was the estimated cost of your implementation project?	
Under $10K	☐
$10k-$25K	☐
$25k-$50k	☐
>$50k	☐
>$100k	☐

Section II

For each barrier, mark the box to the right that best fits your perception of the issue as it pertains to your Training Department. Use the column headings at the top of the table to guide your selection. The last five response blocks may be used for providing and rating additional barriers you may have experienced.

Barrier	Frequency					Impact					Importance				
	Very	Infrequent	Neutral	Frequent	Very	Very Low	Low	Neutral	High	Very High	Very Low	Low	Neutral	High	Very High
Lack of coordination between developers and end-users	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Frustration of end-users with the user interface	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Users not prepared for implementation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lack of an organizational infrastructure to support problem resolution during implementation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lack of organizational infrastructure to support user support after implementation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Absence of high level ownership of the program during implementation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Unexpected cost increases for the system	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Resistance of the users to innovation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Barrier	Frequency					Impact					Importance				
	Very	Infrequent	Neutral	Frequent	Very	Very Low	Low	Neutral	High	Very High	Very Low	Low	Neutral	High	Very High
Lack of awareness of the need for the system by the end-users	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Underestimating the time to implement the system	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Inadequate testing of the system before implementation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lack of a budget for future maintenance and support of the system	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Users felt that training should be the primary means of skill development	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
A perception by the developers that participation of end-users in the development will extend development time – therefore, users were not consulted by developers	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Barrier	Frequency					Impact					Importance				
	Very	Infrequent	Neutral	Frequent	Very	Very Low	Low	Neutral	High	Very High	Very Low	Low	Neutral	High	Very High
A belief that system programmer time was more important than that of the users of the system	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Control issues – Who is in charge of the system	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Focus on system performance and response rather than end-user performance improvement	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
End-users belief that the system is not necessary to meet accreditation requirements	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lack of training for the end-users in the use of the system	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lack of end-user belief that the system will make their jobs easier	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Resistance due to forcing end-users to change the way they do their jobs rather than matching the system to their current work practices	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Barrier	Frequency					Impact					Importance				
	Very	Infrequent	Neutral	Frequent	Very	Very Low	Low	Neutral	High	Very High	Very Low	Low	Neutral	High	Very High
Higher than expected training needs for users to effectively use the system	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Project managers who were not experienced in implementing an Electronic Performance Support System	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Local Senior Management personnel not having a clear understanding of the final purpose of the Electronic Performance Support System and thus withholding needed resources.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Implementation of the system was driven by outside sponsors or agents without the buy-in or support of local management.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Barrier	Frequency					Impact					Importance				
	Very	Infrequent	Neutral	Frequent	Very	Very Low	Low	Neutral	High	Very High	Very Low	Low	Neutral	High	Very High
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Section III

In the following, you are requested to provide additional information related to your experience and satisfaction with the Electronic Performance Support System(s) you have implemented in your Training Department to support your training programs.

	Greatly Disagree	Disagree	*Neutral*	Agree	Greatly Agree
We are satisfied with the performance of the system we implemented.	☐	☐	☐	☐	☐
The system was worth the effort expended for its implementation.	☐	☐	☐	☐	☐
We would implement other Electronic Performance Support Systems in our department.	☐	☐	☐	☐	☐
The system did not provide the gains in efficiency expected.	☐	☐	☐	☐	☐
The instructors using the system believe it has made their jobs easier.	☐	☐	☐	☐	☐

Additional Comments on your experience with barriers to effective implementation of Electronic Performance Support Systems, if desired

Section IV

The final portion of this survey is intended to obtain information related to the current culture in your training department. Corporate culture has been shown to have a significant effect on change efforts. Therefore, there may be culture traits that correlate with implementation barriers. With a better understanding of these relationships, Training Managers may be able to better prepare for, and overcome, these difficulties.

The Organizational Culture Assessment Instrument is based on six questions.
To start, read the four A, B, C, & D statements in Question 1. Then, as you think about the question, distribute 100 points between the four statements to show the degree to which what is said describes your training department TODAY. Continue and do the same for Questions 2, 3, 4, 5, & 6. A sample response is provided.

Sample Question		
A.	Participates well in games with other students.	25
B.	Prefers to work alone.	35
C.	Needs specific directions to be effective.	15
D.	Wants to win, regardless of the cost to others.	25
	Total	100

The Organizational Culture Assessment Instrument

1. Dominant Characteristics

A.	**The organization is a very personal place. It is like an extended family. People seem to share a lot of themselves**	
B.	**The organization is a very dynamic and entrepreneurial place. People are willing to stick their necks out and take risks.**	
C.	**The organization is very results oriented. A major care is getting the job done. People are very competitive and achievement oriented.**	
D.	**The organization is a very controlled and structured place. Formal procedures generally govern what people do.**	
	Total	**100**

2. Organizational Leadership

A.	**The leadership in the organization is generally considered to exemplify mentoring, facilitating, or nurturing.**	
B.	**The leadership in the organization is generally considered to exemplify entrepreneurship, innovating, or risk taking.**	
C.	**The leadership in the organization is generally considered to exemplify a no-nonsense, aggressive, results oriented focus.**	
D.	**The leadership in the organization is generally considered to exemplify coordinating, organizing, or smooth-running efficiency.**	
	Total	**100**

3. Management of Employees

A. The management style in the organization is characterized by teamwork, consensus, and participation.

B. The management style in the organization is characterized by individual risk-taking, innovation, freedom, and uniqueness.

C. The management style in the organization is characterized by hard-driving competitiveness, high demands, and achievement.

D. The management style in the organization is characterized by security of employment, conformity, predictability, and stability in relationships.

Total 100

4. Organizational Glue

A. The glue that holds the organization together is loyalty and mutual trust. Commitment to this organization runs high.

B. The glue that holds the organization together is commitment to innovation and development. There is an emphasis on being on the cutting edge.

C. The glue that holds the organization together is the emphasis on achievement and goal accomplishment. Aggressiveness and winning are common themes.

D. The glue that holds the organization together is formal rules and policies. Maintaining a smooth-running organization is important.

Total 100

5. Strategic Emphasis

A. The organization emphasizes human development. High trust, openness, and participation persist.

B. The organization emphasizes acquiring new resources and creating new challenges. Trying new things and prospecting for opportunities are valued.

C. The organization emphasizes competitive actions and achievement. Hitting stretch targets and winning in the marketplace are dominant.

D. The organization emphasizes permanence and stability. Efficiency, control, and smooth operations are important.

Total 100

6. Criteria of Success

A. The organization defines success on the basis of the development of human resources, teamwork, employee commitment, and concern for people.

B. The organization defines success on the basis of having the most unique or newest products. It is a product leader and innovative.

C. The organization defines success on the basis of winning in the marketplace and outpacing the competition. Competitive market leadership is the key.

D. The organization defines success on the basis of efficiency. Dependable delivery, smooth scheduling, and low-cost production are critical.

Total 100

Appendix B: Request Letter and Instructions

August 3, 2002

RICHARD E. COLE
8686 YELLOWSTONE DRIVE
BYRON, IL 61010

Mr. John Jones
Manager, Training
Typical Nuclear Power Plant
234 Any Street
Any Town, US 23456-6543

Dear Mr. Jones,

I am an Instructional Technologist and Human Performance Coordinator with Exelon Nuclear Corporation at Byron Generating Station. In cooperation with Valdosta State University, I am conducting a study in the nuclear training industry that may help us to more effectively implement technology to support training accreditation and improve the performance of our instructors. You and members of your department are requested to take a few minutes of your valuable time to complete the enclosed survey. All participation is completely voluntary and you may withdraw from this study at any time. This study is part of my doctoral studies in education, and is not sponsored by Exelon Nuclear.

This is a study of barriers to implementation of Electronic Performance Support Systems being used in the nuclear training industry. A survey conducted by Columbia Generating Station in 2001 indicated all fourteen of the utilities contacted are using some form of electronic database to support the systematic approach to training. Several utilities were either preparing original projects (MS Access, Excel, or Word Documents, etc.) or investing in commercial programs to support training (Vision, Taskmaster, etc.).

Research indicates many industries using technology projects to improve human performance are encountering barriers affecting their efficient implementation. Studies in the area of performance improvement and change management indicate there are similarities between organizational change and the predominant organizational culture of the institution. The Institute of Nuclear Power Operations workshop held in Chicago in May of this year included several presentations where large-scale change projects were being used to prepare our industry for deregulation and our changing business climate. A keynote presentation in the workshop was a presentation on organizational culture and its effect on improving human performance.

The purpose of this study is to determine relationships between barriers to implementing EPSS and organizational culture in the nuclear training industry. This study combines an instrument similar to one used at the INPO workshop to determine organizational culture with a survey of training professionals' perceptions of the impact of various barriers to effective implementation of EPSS to support training programs. The training director, selected training managers, instructional technologists, program administrators, and instructors at each of the nuclear stations in the United States (4-5 at each station) are requested to complete and return the enclosed surveys. Trials have demonstrated the survey can be completed in about 20 minutes.

With your assistance, the results of this study will provide the industry a peer-reviewed, quantitative analysis of the relative impact of barriers to implementing EPSS that can be used to improve the effectiveness of these projects in the future. Additionally, the linkage between organizational culture, technological change implementation, and performance improvement resulting from this study could be linked to current or future projects at your station for performance improvement.

Sincerely,

Richard Elliott Cole

Survey Administration

Four or more of the following persons (including at least one manager) who have experience implementing Electronic Performance Support Systems are requested to complete this survey at each nuclear station:

5. Site or Corporate Training Director or Manager
6. Training program Superintendent or Manager (Operations Training Manager, Maintenance Training Manager, etc)
7. Database Administrator or other person responsible for the technical management of development of electronic systems to support training management.
8. Instructional Technologist
9. Instructor(s) experienced with implementation and/or use of an electronic system to support training management.

Directions:

1. Each of the persons at the station participating in the survey will complete one of the enclosed forms. They may be completed using pencil or ink. Responses should be provided directly on the included instruments.
2. A total of five instruments have been included. Additional responses from your station are welcome and additional copies of the survey may be requested from the researcher or made at the station.
3. Each respondent is requested to complete the survey independently based on their best estimate of the proper response to the question.
4. No identification of either stations or individual respondents is desired in this survey. All responses will be maintained in confidence by the researcher and results published only as an aggregate using the demographic information requested in the survey.
5. Completed surveys should be returned in the enclosed self-addressed envelopes within 30 days of receipt at the station.

Contact Information of principal investigator:

Richard E. Cole
8686 Yellowstone Drive
Byron, IL 61010
815-234-4646 H
815-406-3138 W
Richard.Cole@Exeloncorp.com
RCole@Valdosta.edu

Appendix C: Additional Statistics

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Table C1

Descriptive Statistics of Barriers

Barrier	N	Minimum	Maximum	Mean	Std. Deviation
BARR1F Lack of Coordination between developers and users (Freq)	63	1	5	3.29	.941
BARR1I Lack of Coordination between developers and users (Impact)	63	1	5	3.44	.963
BARR1IM Lack of Coordination between developers and users (Importance)	63	3	5	3.95	.607
BARR2F Frustration of end users with interface (Freq)	64	1	5	3.67	.977
BARR2I Frustration of end users with interface (Impact)	64	2	5	3.84	.739
BARR2IM Frustration of end users with interface (Importance)	64	2	5	4.00	.617
BARR3F Users not prepared for implementation (Freq)	64	1	5	3.41	1.050
BARR3I Users not prepared for implementation (Impact)	63	1	5	3.59	.944
BARR3IM Users not prepared for implementation (Importance)	63	1	5	3.87	.751
BARR4F Lack of support infrastructure during implementation (Freq)	63	1	5	3.08	1.005
BARR4I Lack of support infrastructure during implementation (Impact)	64	1	5	3.45	1.083
BARR4IM Lack of support infrastructure during implementation (Importance)	64	1	5	3.72	.881

Barrier	N	Minimum	Maximum	Mean	Std. Deviation
BARR5F Lack of support infrastructure after implementation (Freq)	64	1	5	3.12	1.148
BARR5I Lack of support infrastructure after implementation (Impact)	63	1	5	3.40	1.056
BARR5IM Lack of support infrastructure after implementation (Importance)	63	1	5	3.75	.861
BARR6F Absence of high level ownership during implementation (Freq)	64	1	5	3.16	1.072
BARR6I Absence of high level ownership during implementation (Impact)	64	1	5	3.44	1.097
BARR6IM Absence of high level ownership during implementation (Importance)	64	1	5	3.72	.934
BARR7F Unexpected cost increases (Freq)	59	1	4	2.58	.951
BARR7I Unexpected cost increases (Impact)	59	1	4	2.61	1.017
BARR7IM Unexpected cost increases (Importance)	59	1	5	2.92	.952
BARR8F Resistance of users to innovation (Freq)	64	1	5	3.33	1.055
BARR8I Resistance of users to innovation (Impact)	64	1	5	3.11	1.010
BARR8IM Resistance of users to innovation (Importance)	64	1	5	3.52	.943
BARR9F Lack of awareness of need for system by end users (Freq)	65	1	5	2.88	1.111
BARR9I Lack of awareness of need for system by end users (Impact)	64	1	5	2.98	1.031

Barrier	N	Minimum	Maximum	Mean	Std. Deviation
BARR9IM Lack of awareness of need for system by end users (Importance)	65	1	5	3.35	.943
BARR10F Underestimating the time to implement (Freq)	64	1	5	3.63	1.047
BARR10I Underestimating the time to implement (Impact)	61	1	5	3.57	1.008
BARR10IM Underestimating the time to implement (Importance)	62	2	5	3.65	.925
BARR11F Inadequate testing before implementation (Freq)	64	1	5	3.16	1.087
BARR11I Inadequate testing before implementation (Impact)	62	1	5	3.55	.970
BARR11IM Inadequate testing before implementation (Importance)	63	2	5	3.75	.861
BARR12F Lack of budget for future maintenance and support (Freq)	64	1	4	2.80	1.026
BARR12I Lack of budget for future maintenance and support (Impact)	63	1	5	3.16	1.066
BARR12IM Lack of budget for future maintenance and support (Importance)	63	1	5	3.32	1.045
BARR13F Users felt training should be primary means of skill development (Freq)	62	1	5	3.52	.901
BARR13I Users felt training should be primary means of skill development (Impact)	61	1	5	3.30	.863
BARR13IM Users felt training should be primary means of skill development (Importance)	62	1	5	3.42	.879
BARR14F Developers thought participation by end users would extend development time (Freq)	61	1	5	2.74	1.153

Barrier	N	Minimum	Maximum	Mean	Std. Deviation
BARR14I Developers thought participation by end users would extend development time(Impact)	60	1	5	3.08	1.078
BARR14IM Developers thought participation by end users would extend development time (Importance)	61	1	5	3.28	.968
BARR15F Belief system programmer time more important than users (Freq)	59	1	5	2.81	1.121
BARR15I Belief system programmer time more important than users (Impact)	59	1	5	2.92	1.005
BARR15IM Belief system programmer time more important than users (Importance)	59	1	5	2.92	1.005
BARR16F Control Issues - Who is in charge (Freq)	65	1	5	3.03	1.172
BARR16I Control issues - Who is in charge (Impact)	65	1	5	3.18	1.059
BARR16IM Control issues - Who is in charge (Importance)	65	1	5	3.26	1.050
BARR17F Focus on system performance rather than on user performance improvement (Freq)	64	1	5	3.33	1.113
BARR17I Focus on system performance rather than on user performance improvement (Impact)	64	1	5	3.48	1.039
BARR17IM Focus on system performance rather than on user performance improvement (Importance)	64	1	5	3.50	1.024

Barrier	N	Minimum	Maximum	Mean	Std. Deviation
BARR18F End users believe system not necessary to meet accreditation requirements (Freq)	65	1	5	2.63	1.282
BARR18I End users believe system not necessary to meet accreditation requirements (Impact)	65	1	5	2.89	1.120
BARR18IM End users believe system not necessary to meet accreditation requirements (Importance)	65	1	5	3.18	1.130
BARR19F Lack of training for end users in use of system (Freq)	65	1	5	3.08	1.136
BARR19I Lack of training for end users in use of system (Impact)	65	1	5	3.52	1.091
BARR19IM Lack of training for end users in use of system (Importance)	65	1	5	3.62	1.041
BARR20F Lack of end user belief that system will make their job easier (Freq)	65	1	5	3.55	1.031
BARR20I Lack of end user belief that system will make their job easier (Impact)	65	1	5	3.48	.970
BARR20IM Lack of end user belief that system will make their job easier (Importance)	65	2	5	3.71	.861
BARR21F Resistance due to changing the way users do their jobs instead of matching system to their work (Freq)	65	1	5	3.54	1.076
BARR21I Resistance due to changing the way users do their jobs instead of matching system to their work (Impact)	65	1	5	3.43	1.045

Barrier	N	Minimum	Maximum	Mean	Std. Deviation
BARR21IM Resistance due to changing the way users do their jobs instead of matching system to their work (Importance)	65	1	5	3.66	.906
BARR22F Higher than expected training needs for users to effectively use the system (Freq)	64	1	5	3.13	1.047
BARR22I Higher than expected training needs for users to effectively use the system (Impact)	64	1	5	3.28	.967
BARR22IM Higher than expected training needs for users to effectively use the system (Importance)	64	1	5	3.39	.884
BARR23F Project managers were not experienced in implementing EPSS (Freq)	63	1	5	3.24	1.118
BARR23I Project managers were not experienced in implementing EPSS (Impact)	63	1	5	3.38	1.142
BARR23IM Project managers were not experienced in implementing EPSS (Importance)	63	1	5	3.43	1.073
BARR24F Local senior managers not clear on purpose and withhold resources (Freq)	65	1	5	2.86	1.074
BARR24I Local senior managers not clear on purpose and withhold resources (Impact)	65	1	5	3.31	1.131
BARR24IM Local senior managers not clear on purpose and withhold resources (Importance)	65	1	5	3.51	1.106

Barrier	N	Minimum	Maximum	Mean	Std. Deviation
BARR25F Implementation driven by outside sponsors without local buy-in or support from local managers (Freq)	64	1	5	2.48	1.234
BARR25I Implementation driven by outside sponsors without local buy-in or support from local managers (Impact)	63	1	5	2.75	1.164
BARR25IM Implementation driven by outside sponsors without local buy-in or support from local managers (Importance)	64	1	5	2.92	1.186

Table C2

Respondent Provided Barriers

Respondent Provided Barriers
BARR26 Lack of upgrades promised
BARR27 Inconsistent use of tool by various disciplines
BARR28 Ease of electronic transfer from existing systems to modern systems
BARR29 System support for specific data related to regulatory requirements
BARR30 Computer hardware support for an enterprise system (specific aspect of org. support)
BARR31 Ability to share system cost among several stations / locations
BAR32 Coordination between multiple training departments

Table C3

Coefficient Alphas for Barriers - Frequency

Barrier	Corrected Item-Total Correlation	Alpha if Item Deleted
BARR1F_1	.5496	.9018
BARR2F_1	.4464	.9036
BARR3F_1	.5063	.9024
BARR4F_1	.6760	.8992
BARR5F_1	.6579	.8991
BARR6F_1	.6579	.8993
BARR7F_1	.4584	.9034
BARR8F_1	.4113	.9043
BARR9F_1	.5460	.9016
BARR10_1	.5855	.9009
BARR11_1	.5047	.9025
BARR12_1	.5547	.9015
BARR13_1	.2815	.9063
BARR14_1	.5619	.9012
BARR15_1	.6655	.8991
BARR16_1	.4780	.9031
BARR17_1	.5722	.9010
BARR18_1	.4549	.9039
BARR19_1	.3644	.9055
BARR20_1	.4622	.9033
BARR21_1	.4487	.9036
BARR22_1	.4918	.9027
BARR23_1	.4346	.9039
BARR24_1	.4417	.9037
BARR25_1	.3790	.9055

Reliability Coefficients 25 items
Alpha = .9061 Standardized item alpha = .9068

Table C4

Coefficient Alphas for Barriers - Impact

Barrier	Corrected Item-Total Correlation	Alpha if Item Deleted
BARR1I_1	.5283	.8954
BARR2I_1	.3860	.8982
BARR3I_1	.6461	.8930
BARR4I_1	.6727	.8918
BARR5I_1	.5755	.8942
BARR6I_1	.6075	.8934
BARR7I_1	.5018	.8959
BARR8I_1	.3494	.8991
BARR9I_1	.3982	.8981
BARR10_2	.5380	.8951
BARR11_2	.4678	.8966
BARR12_2	.5013	.8959
BARR13_2	.1609	.9021
BARR14_2	.3870	.8984
BARR15_2	.6127	.8936
BARR16_2	.4274	.8975
BARR17_2	.6349	.8929
BARR18_2	.5600	.8945
BARR19_2	.3920	.8984
BARR20_2	.3994	.8980
BARR21_2	.4572	.8968
BARR22_2	.5159	.8956
BARR23_2	.4199	.8978
BARR24_2	.5782	.8940
BARR25_2	.4531	.8971

Reliability Coefficients 25 items
Alpha = .8999 Standardized item alpha = .8993

Table C5

Coefficient Alphas for Barriers - Importance

Barrier	Corrected Item-Total Correlation	Alpha if Item Deleted
BARR1I_2	.3569	.7724
BARR2I_2	.2410	.7764
BARR3I_2	.4207	.7685
BARR4I_2	.4076	.7679
BARR5I_2	.2971	.7736
BARR6I_2	.3030	.7733
BARR7I_2	.2946	.7737
BARR8I_2	.3847	.7688
BARR9I_2	.1240	.7829
BARR10_3	.4898	.7633
BARR11_3	.1876	.7789
BARR12_3	.2918	.7741
BARR13_3	.2078	.7780
BARR14_3	.2374	.7768
BARR15_3	.4077	.7674
BARR16_3	.3144	.7727
BARR17_3	.3471	.7707
BARR18_3	.4530	.7637
BARR19_3	.3694	.7694
BARR20_3	.2791	.7745
BARR21_3	.0582	.7859
BARR22_3	.2760	.7746
BARR23_3	.3058	.7733
BARR24_3	.4111	.7666
BARR25_3	.3330	.7719

Reliability Coefficients 25 items
Alpha = .7800 Standardized item alpha = .7815

Table C6

Statistically Significant Correlations

		F1FREQ Cost Considerations	F2FREQ Resistance to Change	F3FREQ Ineffective Training Plans	F4FREQ Project Management
F3FREQ Ineffective Training Plans	Pearson Correlation	0.43891			
	Sig. (2-tailed)	0.00025			
	N	65			
F4FREQ Project Management	Pearson Correlation	0.39902			
	Sig. (2-tailed)	0.00099			
	N	65			
F5FREQ Lack of Local Manager Ownership	Pearson Correlation	0.38900			
	Sig. (2-tailed)	0.00136			
	N	65			
F1IMPACT Control Issues	Pearson Correlation	0.60800			0.46691
	Sig. (2-tailed)	0.00000			0.00009
	N	65			65

		F1FREQ Cost Considerations	F2FREQ Resistance to Change	F3FREQ Ineffective Training Plans	F4FREQ Project Management
F2IMPACT Post-Development Issues	Pearson Correlation	0.57391			
	Sig. (2-tailed)	0.00000			
	N	65			
F3IMPACT Project Management	Pearson Correlation	0.44969			0.48556
	Sig. (2-tailed)	0.00017			0.00004
	N	65			65
F4IMPACT Inadequate Implementation Planning	Pearson Correlation			0.43942	0.41780
	Sig. (2-tailed)			0.00025	0.00053
	N			65	65
F5IMPACT Resistance to Change	Pearson Correlation		0.54284	0.39749	
	Sig. (2-tailed)		0.00000	0.00104	
	N		65	65	
F2IMPORT Cost considerations	Pearson Correlation	0.65503			
	Sig. (2-tailed)	0.00000			
	N	65			

		F1FREQ Cost Considerations	F2FREQ Resistance to Change	F3FREQ Ineffective Training Plans	F4FREQ Project Management
F4IMPORT Post-Development Issues	Pearson Correlation			0.39216	
	Sig. (2-tailed)			0.00123	
	N			65	
SATISFIE Satisfied with the performance of system implemented	Pearson Correlation	-0.42719			-0.49756
	Sig. (2-tailed)	0.00039			0.00002
	N	65			65
DIDNOT System did not provide gains in efficiency expected	Pearson Correlation	0.46334			
	Sig. (2-tailed)	0.00012			
	N	64			

Table C6 (Continued—Next 4 Barriers)

		F5FREQ Lack of Local Manager Ownership	F1IMPACT Control Issues	F2IMPACT Post-Development Issues	F3IMPACT Project Management
F1IMPACT Control Issues	Pearson Correlation	0.58226			
	Sig. (2-tailed)	0.00000			
	N	65			
F3IMPACT Project Management	Pearson Correlation		0.40838		
	Sig. (2-tailed)		0.00073		
	N		65		
F4IMPACT Inadequate Implementation Planning	Pearson Correlation				0.40955
	Sig. (2-tailed)				0.00070
	N				65
F5IMPACT Resistance to Change	Pearson Correlation	0.39943			0.39898
	Sig. (2-tailed)	0.00098			0.00099
	N	65			65
F2IMPORT Cost considerations	Pearson Correlation		0.74276	0.40688	
	Sig. (2-tailed)		0.00000	0.00077	
	N		65	65	

		F5FREQ Lack of Local Manager Ownership	F1IMPACT Control Issues	F2IMPACT Post-Development Issues	F3IMPACT Project Management
F4IMPORT Post-Development Issues	Pearson Correlation			0.68119	
	Sig. (2-tailed)			0.00000	
	N			65	
F5IMPORT Project Management	Pearson Correlation				0.48306
	Sig. (2-tailed)				0.00005
	N				65

Table C6 (Continued—Next 4 Barriers)

		F4IMPACT Inadequate Implementation Planning	F5IMPACT Resistance to Change	CLAN Clan Culture	ADHOCRAC Adhocracy Culture
F1IMPORT Lack of End-User Buy-in	Pearson Correlation		0.41410		
	Sig. (2-tailed)		0.00061		
	N		65		
F3IMPORT Resistance to Change	Pearson Correlation	0.44135			
	Sig. (2-tailed)	0.00023			
	N	65			
MARKET Market Culture	Pearson Correlation			-0.71541	
	Sig. (2-tailed)			0.00000	
	N			65	
HIERARCH Hierarchy Culture	Pearson Correlation				-0.51313
	Sig. (2-tailed)				0.00001
	N				65

Table C6 (Continued—Next 4 Barriers)

		SATISFIE Satisfied with the performance of system implemented	WORTHEFF System was worth effort expended	DIDNOT System did not provide gains in efficiency expected	MULTISIT Part of Multi-Site Utility
WORTHEFF System was worth effort expended	Pearson Correlation	0.63999	1		
	Sig. (2-tailed)	0.00000			
	N	65			
DIDNOT System did not provide gains in efficiency expected	Pearson Correlation	-0.48967	-0.57272	1	
	Sig. (2-tailed)	0.00004	0.00000		
	N	64	64		
INSTBELI Instructors using system believe it has made their job easier	Pearson Correlation	0.51742	0.58266	-0.59893	
	Sig. (2-tailed)	0.00001	0.00000	0.00000	
	N	64	64	64	
NETWORKE Networked EPSS for multiple sites	Pearson Correlation				0.40000
	Sig. (2-tailed)				0.00116
	N				63

		SATISFIE Satisfied with the performance of system implemented	WORTHEFF System was worth effort expended	DIDNOT System did not provide gains in efficiency expected	MULTISIT Part of Multi-Site Utility
COST Estimated cost of implementation	Pearson Correlation			0.47836	
	Sig. (2-tailed)			0.00033	
	N			52	

Table C6 (Continued—Last 3 Barriers)

		INHOUSE EPSS Developed In-house	THIRD_P Developed by 3rd Party	NETWORKE Networked EPSS for multiple sites
NETWORKE Networked EPSS for multiple sites	Pearson Correlation	-0.42238	0.42450	1
	Sig. (2-tailed)	0.00063	0.00065	
	N	62	61	
COST Estimated cost of implementation	Pearson Correlation			-0.45231
	Sig. (2-tailed)			0.00076
	N			52

Table C7

ANOVA of Overall Satisfaction with Electronic Performance Support System -All

		Sum of Squares	df	Mean Square	F	Sig.
WORTHEFF System was worth the effort expended	Between Groups	.396	1	.396	.387	.536
	Within Groups	62.461	61	1.024		
	Total	62.857	62			
SATISFIE Satisfied with the performance of system implemented	Between Groups	.783	1	.783	.627	.431
	Within Groups	76.201	61	1.249		
	Total	76.984	62			
DOAGAIN Would implement another EPSS in our department	Between Groups	.187	1	.187	.242	.625
	Within Groups	47.083	61	.772		
	Total	47.270	62			
DIDNOT System did not provide gains in efficiency expected	Between Groups	3.912	1	3.912	4.309	**.042**
	Within Groups	54.475	60	.908		
	Total	58.387	61			
INSTBELI Instructors using system believe it has made their job easier	Between Groups	.458	1	.458	.443	.508
	Within Groups	61.930	60	1.032		
	Total	62.387	61			

Appendix D: Institutional Review Board Approval

APPROVAL DATE 07/30/02
IRB # 01050-2002
EXPIRATION DATE 07/29/03
VALDOSTA STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD

Institutional Review for Human Subjects Research

Office of Grants and Contracts, Valdosta State University
Research Qualifying for Exemption from Federal Regulations
for the Protection of Human Subjects
(Based on the Code of Federal Regulations, Title 45, Part 46.101.
and the Valdosta State University Policy on Human Subjects)

University procedures provide for review of research involving human subjects that may be exempt under federal, state, and university regulations. The exempt categories and exceptions are described on the reverse of this form. Exempt research may be approved by the IRB Administrator provided it is in accord with the Code of Federal Regulations and the general principles stated in the VSU Policy on Human Subjects. This form, properly endorsed, certifies that the research described here qualifies for exemption.

Principal Investigator Richard E. Cole **Academic Title** Student
Department/College Education / Adult and Career Education **Telephone** 815-234-4646
Project Title Training Professionals Perceptions: A Study of the Relationships Between Corporate Culture and Barriers to Implementing Electronic Performance Support Systems in Nuclear Industry Training
E-mail rcole@valdosta.edu; Richard.Cole@exeloncorp.com
Starting Date July 30, 2002 **Anticipated Termination Date** July 29, 2003
If PI is a student, provide Faculty sponsor/mentor's name Dr. Murdock
Grant (if sponsored) Title (if applicable) N/A
Funding Agency and application due date (if applicable) N/A

I. The category under which this research qualifies for exemption (categories are described on page 2) is circled:

1 (2) 3 4 5 6

II. ABSTRACT: Brief description of a) purpose of the research, b) what subjects will do (if applicable), c) the nature of the data to be obtained, and d) how anonymity or confidentiality will be maintained. Additional sheet may be attached. Note: This section is obtained directly from the Application for Review completed by the PI.

The purpose of an Electronic Performance Support System is to improve worker performance and productivity using automated tools, sometimes called coaches, wizards, expert systems, or other task specific electronic job-aids. To improve worker efficiency, Electronic Performance Support Systems are gaining acceptance as an increasingly important tool in the nuclear industry (Jenco, 2002). The population for this study will be instructors, instructional technologists, database administrators, and Training Managers at nuclear power plants. A survey will be mailed to the Training Manager at each nuclear station with a letter requesting their participation. Analysis of the data collected will be provided; conclusions, implications, and recommendations for future research will be provided.

III. Human Subjects (to be considered 'exempt' all of these responses must be answered "NO"):	**YES**	**NO**
Are any subjects presumed to be not legally competent?	☐	☒
Are any subjects under 18 years of age?	☐	☒
Are any subjects confined in a correctional or detention facility?	☐	☒
Is pregnancy a prerequisite for serving as a subject?	☐	☒
Are fetuses *in utero* subjects in this research?	☐	☒
Are personal records (medical, academic, etc.) used without written consent?	☐	☒
Are data from subjects (responses, information, specimens) directly or indirectly identifiable?	☐	☒
Are data damaging to subjects' financial standing, employability or reputation?	☐	☒
Is material obtained at autopsy used in the research?	☐	☒

IV. The information provided above is based on the material provided in the Application for Review of Research presented to the Institutional Review Board of Valdosta State University dated (month, day and year) 07/31/02. Based on this application, this research is certified as exempt from federal regulations and is in accord with the general principles stated in the VSU Policy for the Protection of Human Subjects. ~~Signed and sealed~~

V. IRB Signature [signature] **Date** 07/31/02

cc: Faculty Advisor

VALID FOR ONE YEAR AS LONG AS APPROVED PROCEDURES ARE UNCHANGED

RESEARCH QUALIFYING FOR EXEMPTION FROM FEDERAL REGULATIONS FOR THE PROTECTION OF HUMAN SUBJECTS

(Quoted from the Code of Federal Regulations, Title 45, Part 46.101.)

(1) **Educational Research Conducted in Educational Settings:** "Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (I) research on regular and special education instructional strategies, or (II) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods."

(2) **Survey/Interview/Observational Research:** "Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior unless: (I) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (II) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation."

(3) **Survey/Interview Research not Exempted in (2) Above:** "Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b) (2) of this section, if: (I) the human subjects are elected or appointed public officials or candidates for public office; or (II) Federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter."

(4) **Secondary Use of Existing Data:** "Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified directly or through identifiers linked to the subjects." (See below for exceptions.)

(5) **Evaluation and Demonstration Projects of Federal Programs:** "Research and demonstration projects which are conducted by or subject to the approval of Department or Agency heads, and which are designed to study, evaluate, or otherwise examine: (I) Public benefit or service programs; (II) procedures for obtaining benefits or services under those programs; (III) possible changes in or alternatives to those programs or procedures; or (IV) possible changes in methods or levels of payment for benefits or services under those programs."

(6) **Taste and Food Quality Studies:** "Taste and food quality evaluation and consumer acceptance studies, (I) if wholesome foods without additives are consumed or (II) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture."

Exceptions:
See the ***Valdosta State University Policy for Protection of Human Subjects***
(http://www.valdosta.peachnet.edu/*grants/ forms/irb/irb98a.html*) and the following for clarifying notes on and exceptions to above exemption categories.

1. Research activities involving: minor subjects except in the case of categories 1 and 2, above: pregnant women where pregnancy is the focus of the research; prisoners; fetuses *in utero*; or persons incompetent to provide informed consent.
2. Research involving the use of medical, academic and other personal records (including psychiatric records) without consent.
3. Research involving the use of tissue obtained at autopsy.

GENERAL PRINCIPLES OF RESEARCH WITH HUMAN SUBJECTS

A. **Valdosta State University and the individual members of its faculty, staff and student body recognize their responsibility for** protection of the rights and welfare of human subjects.

B. Appropriate professional attention and facilities shall be provided to insure the safety and well being of human subjects. No subject in a research activity shall be exposed to unreasonable risk to health or well being.

C. Research involving children (persons under 18 years of age), other legal incompetents, and persons unable to give informed consent may be approved if there is no risk of suffering for the individual subject. On the other hand, research involving a child, other legal incompetent, or a person unable to give informed consent should not be approved if there would be a significant risk of suffering without the possibility of benefit to the individual subject.

D. The confidentiality of information received from subjects in experiments or respondents to questionnaires shall be fully protected both during and after the conduct of a research activity, within the limits of the law.

E. Before a subject participates in research involving risk or substantial stress or discomfort, this shall be carefully explained; the investigator shall be satisfied that the explanation has been understood by the subject; and the consent of the subject shall be obtained. The elements of informed consent are established by the federal government and by the University.

F. A request by any subject for withdrawal from a research activity shall be honored promptly without penalty or without loss of benefits to which the subject is otherwise entitled, within the limits of the research.